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Impact of global change on ground subsidence related to aquifer exploitation. The case of the Vega de Granada aquifer (SE Spain)

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In this research, we intend to develop a methodology to assess the impact of potential global change scenarios on land subsidence. Subsidence rates in wide areas could be estimated by using remote sensing techniques, such as DInSAR and specifically the new radar information obtained by the Sentinel set of satellites from the European Space Agency (ESA). A symbolic regression method will be developed to obtain an explicit quantitative relationship between subsidence, hydraulic head changes and other physical variables (e.g. percentage of clay and silt in the ground, load of buildings and constructions, fill-in works etc.). Different ensemble and downscaling techniques will be used to define potential future global change scenarios for the test-regions based on the data coming from simulations with different Regional Circulation Models (RCMs). Future drawdowns can be estimated from these global change scenarios under different management options. The regression approach will be employed to simulate the impacts of these drawdowns, in terms of land-subsidence, taking into account the estimated hydraulic head changes. It will allow to assess sustainable management of detrital aquifers taking into account subsidence issues. Classic regression analysis attempts to postulate a hypothesis function f, and the regression is reduced to the problem of finding the optimal parameters w of the hypothesis y=f(x, w), to explain a set of dependent variables y from the values of independent variables x, where x and y are known input/output data. Symbolic regression generalizes this process by assuming that f is also unknown in advance, so that the problem is formulated as finding the optimal analytical expression and its parameters that best approximate the data y considering the data in x. To achieve that purpose, in this work Straight Line Programs (SLP) will be used to represent analytical expressions, and a genetic programming approach will be used to find an optimal SLP that better explains the relationship between subsidence, hydraulic changes and the remaining independent variables. This methodology has been applied to the Vega de Granada aquifer system (Granada, SE Spain). The Vega de Granada detrital aquifer (with an extension of 200 km2) is one of the largest groundwater reservoirs in Andalusia and it is considered as strategic for the economy of this semi-arid region. Ground motion was monitored by exploiting SAR images from ENVISAT (2003-2009), Cosmo-SkyMed (2011-2014) and Sentinel-1A (2015-2016). PSInSAR results show an inelastic deformation in the aquifer and land surface displacements values up to -55 mm. The most widespread land subsidence is detected for the ENVISAT period (2003-2009), which coincided with a dry, long period in the region. The highest recorded data accounts up to 10 mm/yr in surface displacement velocity, which were detected in the central part of the aquifer, where many villages are located. For this period, a good correlation between groundwater level depletion and the augmentation of the subsidence average velocity is obtained, and light hydraulic head changes (< 2 m) have a rapid ground motion response. This research will contribute to assess a sustainable management plan of this vital aquifer, taking into account critical levels of groundwater level depletion to avoid land subsidence on the identified vulnerable areas and during drought critical scenarios.

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