IAF EARTH OBSERVATION SYMPOSIUM (B1)
Earth Observation Applications, Societal Challenges and Economic Benefits (5)

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QUANTITATIVE ASSESSMENT OF VERTICAL AND HORIZONTAL DEFORMATIONS DERIVED BY 3D AND 2D DECOMPOSITIONS OF INTERFEROMETRIC LOS MEASUREMENTS TO SUPPLEMENT OPTIMIZED, SAFE AND COST REDUCED CASPIAN REGION PETROLEUM & GAS INDUSTRY RISK MANAGEMENT

Abstract

This petroleum and gas industry-oriented research focused on the quantitative assessment of the surface deformation velocities and cumulative vertical displacement and their natural and man-made controlling factors in the Tengiz oilfield of Kazakhstan using the Small Baseline Subset remote sensing technique followed by 3D and 2D decompositions and cosine corrections to derive vertical and horizontal movements from line-of-sight (LOS) measurements. In the present research we applied time-series of Sentinel-1, COSMO-SkyMed and TerraSAR-X satellite images acquired during 2018–2020. All ground deformation derivatives showed the continuous subsidence at the Tengiz oilfield with increasing velocity. 3D and 2D decompositions of LOS measurements to vertical movement showed that the Tengiz oilfield, during 2018–2020 continuously subsided with the maximum annual vertical deformation velocity around 70 mm. Based on the LOS measurements, the maximum annual subsiding velocity was observed to be 60 mm. Cosine corrections of LOS measurements to vertical movement, however, revealed a maximum annual vertical deformation velocity of 77 mm. The vertical deformation confirmed typical patterns of subsidence caused by oil extraction. Detected east-west and north-south horizontal movements in the Tengiz oilfield clearly indicated that the study area crossed by seismic faults is affected by natural tectonic processes. The overall RMSE of 3D decomposed vertical deformation in relationship to LOS measurements and cosine corrections were in the range of 10–13 mm and 6–8 mm, correspondingly. The results of the present research will support operators of petroleum and gas fields and also other types of infrastructure to evaluate the actual differences of interferometric ground deformation measurements against the required standards and the precision of measurements depending on the operational needs, time-frames and availability of SAR imagery.