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OPTIMIZED GEOHAZARDS MONITORING, ASSESSMENT AND MAPPING USING MULTI-SOURCE EARTH OBSERVATION MICROWAVE SATELLITE MISSIONS FOR THE CASPIAN SEA COASTAL PETROLEUM AND GAS INDUSTRY

Abstract

The present study was aimed at comparing vertical and horizontal surface displacements derived from the Cosmo-SkyMED, TerraSAR-X and Sentinel-1 satellite missions for the detection of oil extraction-induced subsidence in the Tengiz oilfield during 2018–2022. The vertical and horizontal surface displacements were derived using the 2D decomposition of line-of-sight measurements from three satellite missions. Vertical displacement velocities derived from 2D Decomposition showed a good agreement in similar ground motion patterns and an average regression coefficient of 0.98. The maximum average vertical subsidence obtained from the three satellite missions was observed to be 57 mm/year. Higher variations and deviations were observed for horizontal displacement velocities in terms of similar ground motion patterns and an average regression coefficient of 0.80. Fifteen wells and three facilities were observed to be located within the subsidence range between 55.6 mm/year and 42 mm/year. The spatial analyses in the present studies allowed us to suspect that the subsidence processes occurring in the Tengiz oilfield are controlled not solely by oil production activities since it was clearly observed from the detected horizontal movements. The natural tectonic factors related to two seismic faults crossing the oilfield, and terrain characteristics forming water flow towards the detected subsidence hotspot, should also be considered as ground deformation accelerating factors. The novelty of the present research for Kazakhstan's Tengiz oilfield is based on the cross-validation of vertical and horizontal surface displacement measurements derived from three radar satellite missions, 2D Decomposition of Cosmo-SkyMED descending and TerraSAR-X ascending line-of-sight measurements and spatial analysis of man-made and natural factors triggering subsidence processes. These studies play an important role in determining surface displacements induced by fluid extraction and injection for modeling of reservoir dynamic behavior and perform necessary improvements to achieve more effective exploitation and geohazards' risk assessment principles. It is well-known that dense and highly precise vertical and horizontal displacements are critical information for regular reservoir monitoring, characterization and geomechanical analysis.