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Monitoring of sinkholes and subsidence affecting the Jordanian coast of the Dead Sea through Synthetic Aperture Radar data and last generation Sentinel-1 data

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Since the mid-1980s the coast of the Dead Sea is affected by sinkholes occurring over and around the emerged mud and salt flats. Strong subsidence and landslides also affect some segments of the coast. Nowadays, several thousands of sinkholes attest that the degradation of the Dead Sea coast is worsening. Furthermore, soil deformations are interesting the main streets running along both the Israeli and Jordanian sides of the Dead Sea.
These hazards are due to the dramatic dropping of the Dead Sea level, characterized by an increasing rate from about 60 cm/yr in the 1970s up to 1 m/yr in the 2000s, which provokes a lowering of the fresh-saline groundwater interface, replacing the hypersaline groundwater with fresh water and causing a consequent erosion of the subsurface salt layers. Subsidence, sinkholes, river erosion and landslides damage bridges, roads, dikes, houses, factories worsening this ongoing disaster. One of the most emblematic effects is the catastrophic collapse of a 12-km newly constructed dyke, located on the Lisan Peninsula (Jordan), occurred in 2000.
Differential Interferometric Synthetic Aperture Radar (DInSAR) techniques and Advanced stacking DInSAR techniques (A-DInSAR) were applied to investigate sinkholes and subsidence affecting the Jordanian coast of the Dead Sea. The use of SAR data already proof to be efficient on the risk management of the area, allowing to identify a vulnerable portion of an Israeli highway, averting a possible collapse.
Deformation analysis has been focused on the Ghor Al Haditha area and Lisan peninsula, located in the South-Eastern part of the lake coast. The availability of a huge database of SAR data, since the beginning of the 90s, allowed to observe the evolution of the displacements which are damaging this area. Furthermore, last generation Sentinel-1 data, acquired by the ESA mission, were processed to obtain information about the recent evolution of the subsidence and sinkholes affecting the study area, from the end of 2014 to the present. Important subsidence can be noticed mainly in correspondence of the emerging coast. Moreover, some solar evaporation pools used for salt production are injured by high deformations. Analysis of results obtained from SAR satellite data allows to identify different hazard processing affecting the study area and define the displacement time-series to clearly describe the evolution of the different phenomena, resulting as an effective tool to prevent damage and collapses. Furthermore, vulnerability maps can be created and possible precursor behaviour can be highlighted demonstrating the predictive capability of these data.