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Water induced geohazards measured with spaceborne interferometry techniques

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Natural and anthropogenic occurrence of groundwater is inducing surficial crustal deformation processes that can be accurately measured with high spatial density from space, regardless of the ground access conditions. The detection of the surface deformation allows uncovering spatial and temporal patterns of subsurface processes such as land subsidence, cave-ins and differential ground settlement related to water content. InSAR measurements combined with ground truth data permit estimation of the mechanical properties of the rocks and the development of models and scenarios to predict disaster events such as cave-ins, landslides and soil liquefaction in the case of an Earthquake.
A number of three sites in Romania that suffer of ground instability because of the water component will be presented. The DInSAR, Interferograms Stacking and Persistent Scatterers Interferometry techniques were applied to retrieve as accurate as possible the displacement information.
The first studied site is the city of Bucharest; using 7 years of ERS data ground instability was detected on a large area that represents the historical watershed of the Dambovita river. A network of water wells shows that the ground instability is directly proportional to the groundwater depth.
The second site is the Ocnele Mari brine extraction area. The exploitation of the Ocnele Mari salt deposit started from the Roman Empire time using the mining technology and from 1954 the salt dissolution technology which involves injecting water into the ground using a well and extracting the brine (water and salt) through another well. The extraction of salt through dissolution led to slow ground subsidence but the flooding and dissolution of the Roman caves led to catastrophic cave-ins and the relocation of an entire village. The water injection technique is still applied and the Roman cave system is an unknown, therefore further catastrophic events are expected. The existing theoretical simulations of the subsidence process are performed using a Finite Element Method (FEM), which calculates the distribution of the state of strains and stresses in the rock masses, in an elasto-plastic behavior. The ground deformation is presently measured with leveling instrumentation and an effort is being made to adopt the InSAR results for a better spatial and temporal coverage that should refine the existing model.
The third site is a number of 4 tailing retention ponds at different stages of their life. The tailing ponds are hydrotechnical structures of permeable type designed for the safe storage of mining detritus byproducts and disposal of the water contained in these byproducts. Starting in 1998 approximately 550 mines have been closed and introduced in a conservation process. In order to prevent ecological and human damage, all these mines and storage ponds for mining tailings are required to be under continuous monitoring. Using 15 high-resolution Spotlight TerraSAR-X images, the stability of the storage pond was monitored over a period of 5 months during 2011. Interferometric stacking techniques and PSI analysis were applied in order to generate deformation maps and deformation profiles. In the same time, GPS measurements and Electrical Tomography for water content were used as independent measurements.