Rapidly accelerating subsidence in Maceió (Brazil) analyzed by multi-temporal DInSAR analysis and 2D geomechanical modeling

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The densely populated neighborhoods of Pinheiro, Bebedouro, Mutange, Bom Parto and Levada in the Municipality of Maceió (Brazil) are suffering serious geological instability. Fractures, on both buildings and roads, have intensified since the beginning of 2018 and some of the areas were evacuated, due to safety reasons, by the local authorities during the second half of 2019. The preliminary investigation conducted by the Brazilian Geological Service (Serviço Geológico do Brasil - CPRM), suggested that the direct cause of the instability is connected to the salt mining activities carried out on near the cost of the Mundaú Lagoon.

In this study we use radar interferometry (InSAR) and 2D geomechanical modelling to characterize almost 16 years of continuous deformation in Municipality of Maceió (Brazil). We exploited the full potential of the well-known Multi Temporal Interferometry techniques (MTI) based on Advanced Synthetic Aperture Radar Differential Interferometry (A-DInSAR) and processed all available historical and currently operational SAR missions: the C-band ASAR ENVISAT, the L-band ALOS-1 POLSAR, L-band ALOS-2 POLSAR and C-band Sentinel-1 missions. The results show clear main deformation field over the neighborhood of Pinheiro with concentric pattern to the shore and increasing deformation intensity up to 25cm per year from 2003 to 2019. A minor deformation area is detected also south of the lagoon corresponding to the neighborhood of Bom Parto and Levada. A 2D geomechanical modelling of salt-cavern stability using Distinct Elements is developed to derive the relationship between the detected deformations and the salt mining activities. As a general conclusion, our study shows how MTI analysis is very efficient and reliable tool for emergency management purposes. Especially after the launch of the Sentinel-1 mission, which provides an acquisition in single pass every 12 days, we are able to detect when a surface displacement commence and monitor the deformation progress and status in time.