TerraSAR-X Monitoring of Ground Deformation from Brine Extraction

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Introduction

This work presents the first results of an interferometric analysis using High Resolution Spotlight TerraSAR-X data for monitoring ground deformation caused by salt extraction in Ocnele Mari, Romania, within the TerraSAR-X proposal LAN0778.

Ocnele Mari is a town located in the central-southern part of Romania, in Sub-Carpathians. The settlement lies in a basin at an altitude of about 300 m, surrounded by hills. Under these hills there is a massive salt deposit about 400 m thick, which has been exploited since ancient times and gives also the town's name ("ocna" means "salt mine").

Fig. 1 In 2009, underground caverns created by salt mining have collapsed over an area of 50 hectares, causing many environmental and especially, social problems.

The main objective of the ongoing project is the evaluation of the TerraSAR-X data potential for elaborating long time deformation maps for the regions affected by brine extraction.
A set of 20 TerraSAR-X High Resolution Spotlight images will be acquired.
This interferometric monitoring is the first one of this type for Ocnele Mari region.

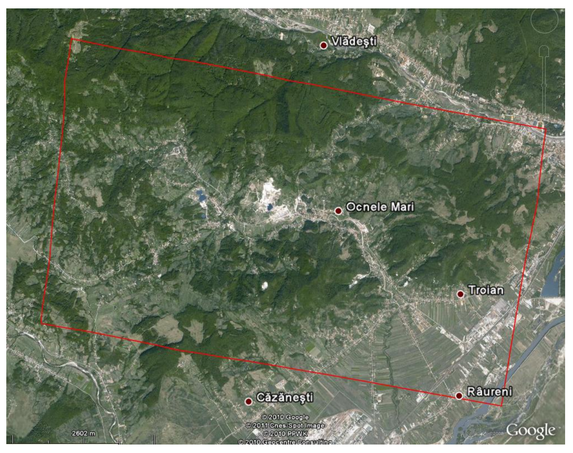


Fig. 2 The footprint of the radar data on the ground

Interferometric and Leveling Measurements

The 9 high resolution TerraSAR-X images acquired between 05.08 – 23.11.2010 were combined to form a set of 6 differential interferograms with perpendicular baseline smaller than 200 m. These interferograms were further processed to obtain the corresponding geocoded deformation maps (e.g. Fig. 3), and, by stacking, also a deformation map over the entire available period of time (Fig. 6).

The results of the DInSAR analysis were correlated with the leveling measurements done by the University of Bucharest, Faculty of Geology and Geophysics. There are available accurate leveling measurements on the probe flanges from Ocnele Mari fields of exploitation starting from 1972 and until 2009 (e.g. Fig. 4, 5).

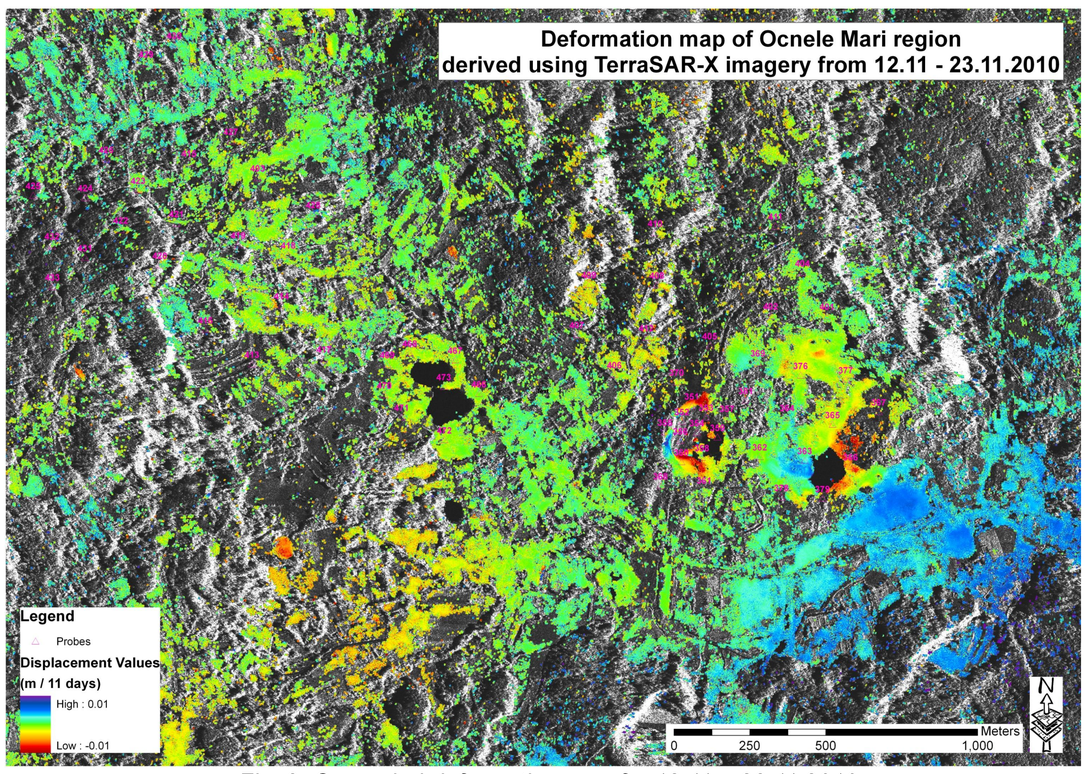


Fig. 3 Geocoded deformation map for 12.11 – 23.11.2010

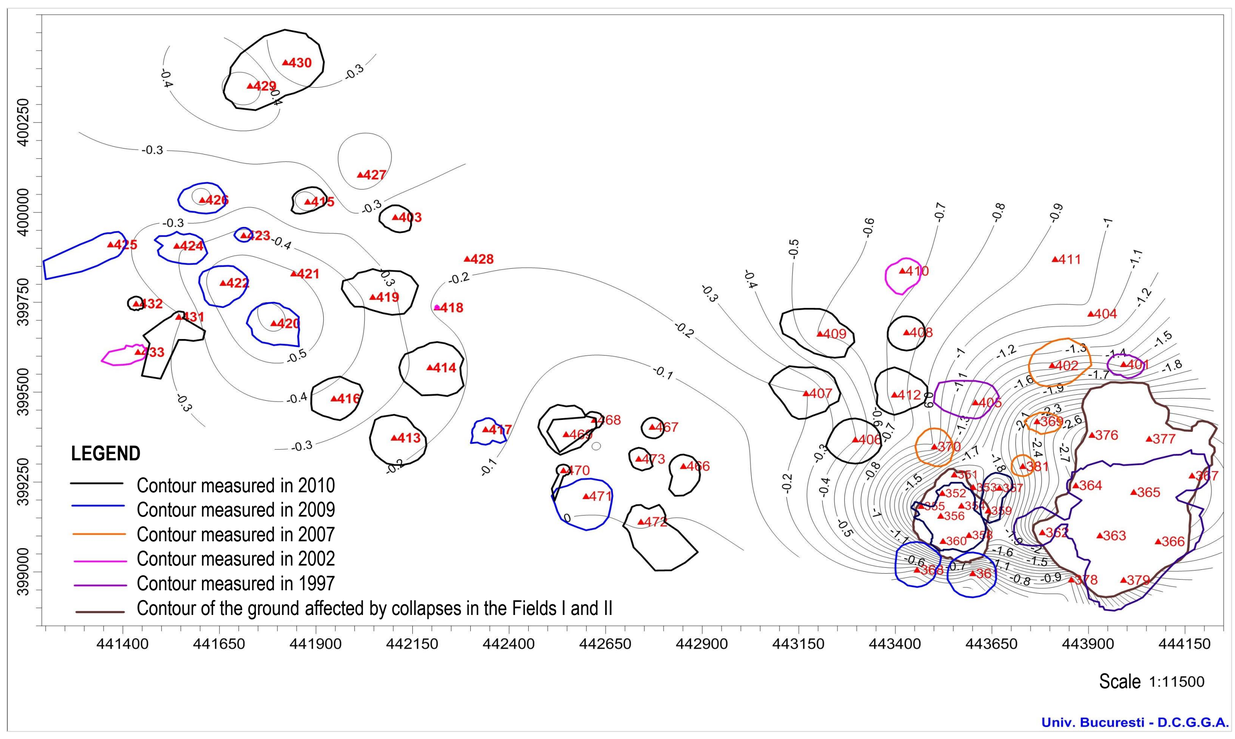
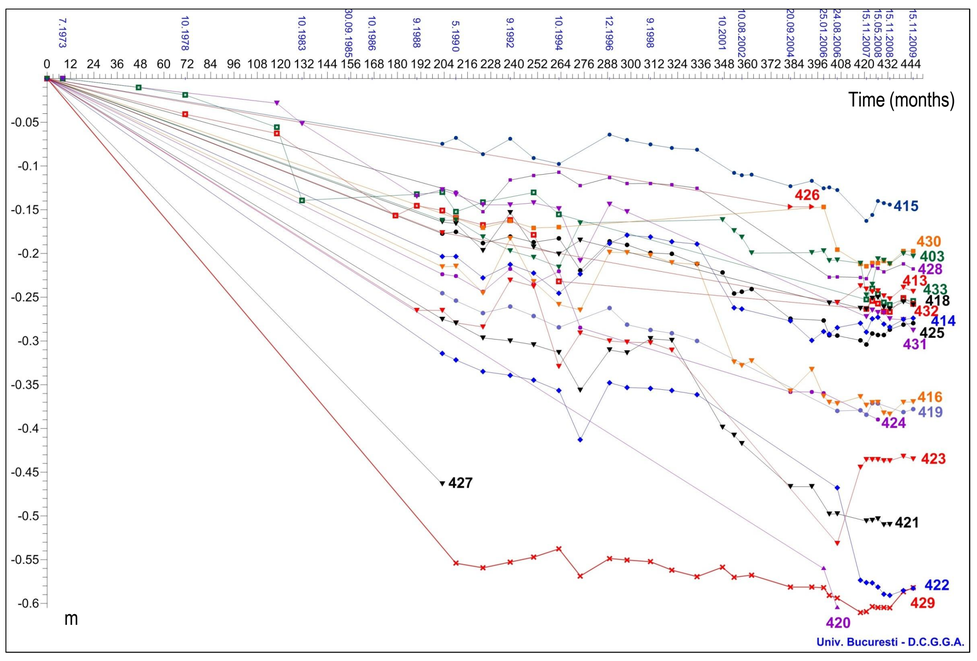
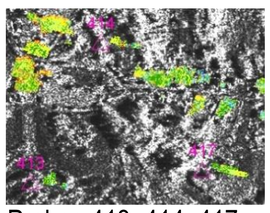


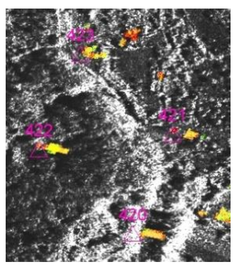
Fig. 4 Isolines showing total subsidence [m] between 1972 – 2009, derived from leveling measurements on the probes (courtesy of F. Zamfirescu & M. Mocuta, Fac. Geology Geophysics, Univ. Bucharest)

Analyzing the leveling measurements displayed in Fig. 5, it can be concluded that the steepest gradient, i.e. fastest subsidence, is observed on the probes 420 - 423. The deformation map from Fig. 6 yields 3-4 mm/month subsidence on the probes 420 - 423, while the probes 413, 414, 417 are quite stable. Thus the DInSAR results correlate very well with the existing leveling measurements.





Probes 413, 414, 417: relatively stable



Probes 420 - 423: ~ 3 mm/month subsidence

Fig. 5 Left: Total subsidence [m] measured between 1972-2009 on the probes from Field III. Right: interferometric results on some probes from Field III taken from the deformation map in Fig. 6.

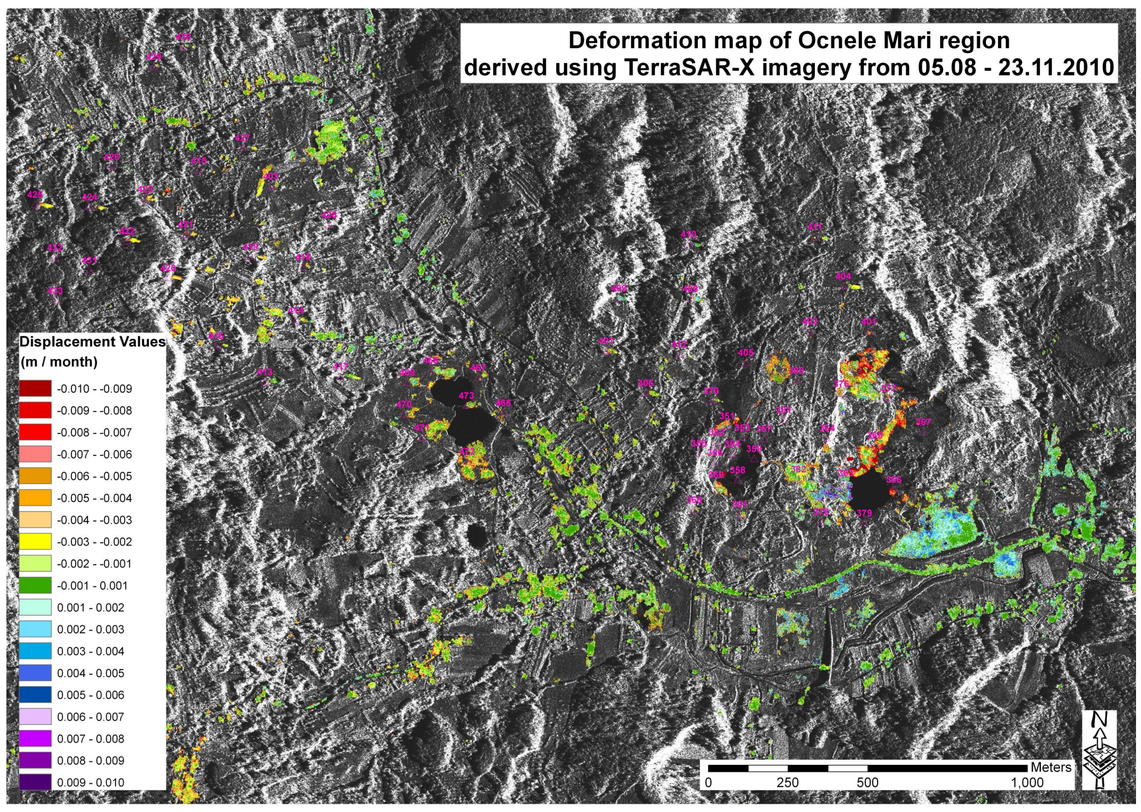


Fig. 6 Geocoded deformation map, showing displacements rates per month

Further Work

The interferometric measurements confirm until now the subsidence trend observed through leveling measurements. Acquisition of TerraSAR-X data will be continued and deformation profiles derived from Persistent Scatterers Interferometry will be created.

Acknowledgements

The interferometric processing was partly performed with the DORIS software from Delft University of Technology, Netherlands.
TerraSAR-X data was acquired within the TerraSAR-X proposal LAN0778 submitted to DLR in 2010.