Land deformation monitoring in the Ocnele Mari salt mining area using VHR TSX data

V. Poenaru[1], I. Dana[1], D. Teleaga[2], V. Poncos[2]

[1]Romanian Space Agency [2]Advanced Studies and Research Center

Introduction

The object of the present work is to assess how feasible are InSAR, DInSAR and PSInSAR techniques for a given area with natural landscape based on the efficient planning of acquisition of long SAR image time series and their processing (LAN0778 proposal).

The salt deposit from Ocnele Mari area is located in the central-southern part of Romania, in the Valcea Sub-Carpathians area which is affected by uplift geotectonic movements at a rate of 2-4 mm/year, surrounded by hills with an altitude between 400m and 600m (Fig. 1). The climate is temperate continental with an average precipitation of 700 mm/year, up to 1.225 mm and 1.295 mm registered in rainy years which favour soil erosion and gulling.

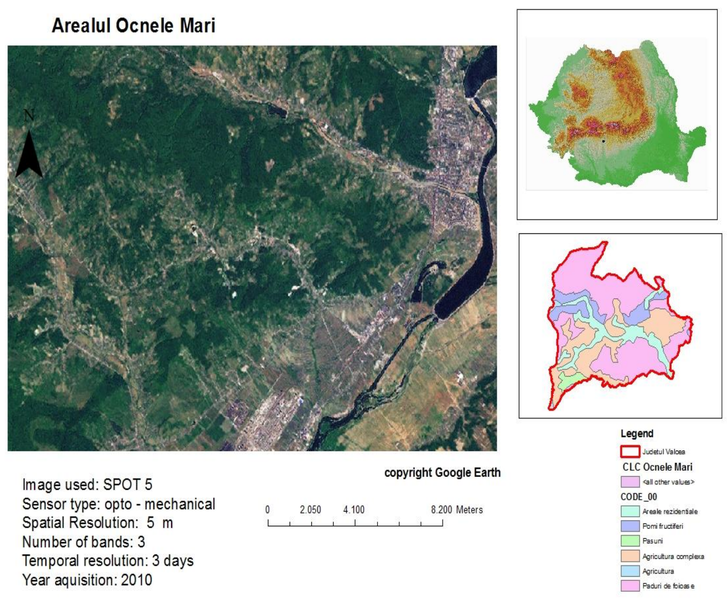

Fig. 1. Ocnele Mari salt mine area – Corine land cover classification

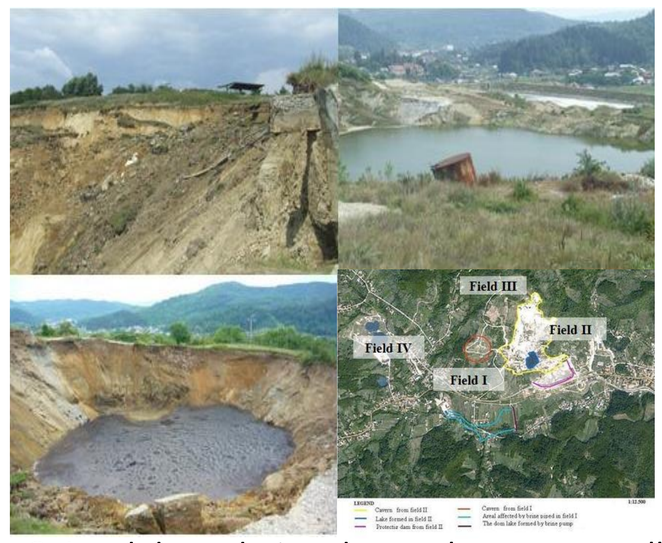

Fig. 2. Land degradation due to the caverns collapses from 2005, 2007 and 2009

Interferometric and in-situ measurements

A set of 20 VHR TS-X data image has been acquired during one year time span (from august 2010 to august 2011). The InSAR processing was focused on finding the most suitable interferogram pair to derive a digital elevation model (DEM) with a good accuracy (fig.3). The image data were combined to form differential interferograms with perpendicular baseline smaller than 200 m. Previous results -deformations map derived using TS-X imagery from August to December 2010- shown that DInSAR analysis is correlated with leveling measurements. Analyzing the all differential interferograms acquired from May to Augyst 2011 it can be concluded that the slow subsidence as well as the rapid mining subsidence caused by water inflow into caverns derived from DInSAR is not correlated with leveling surveys (the coherence is loss due to vegetation coverage) (Fig.4). PSInSAR analysis was consisted of the identification of the PS candidates using thresholds or amplitude dispersion index modelling PSInSAR time series without phase unwrapping . This method works well in areas with either linear or nonlinear ground deformations (Fig.5).

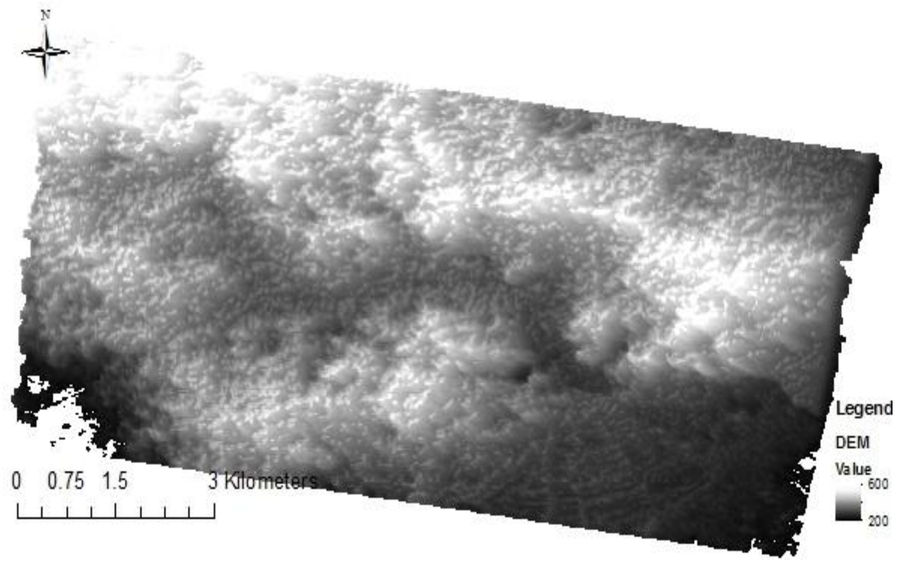

Fig. 3. DEM derived from 04-15.12.2010 interferometric pair

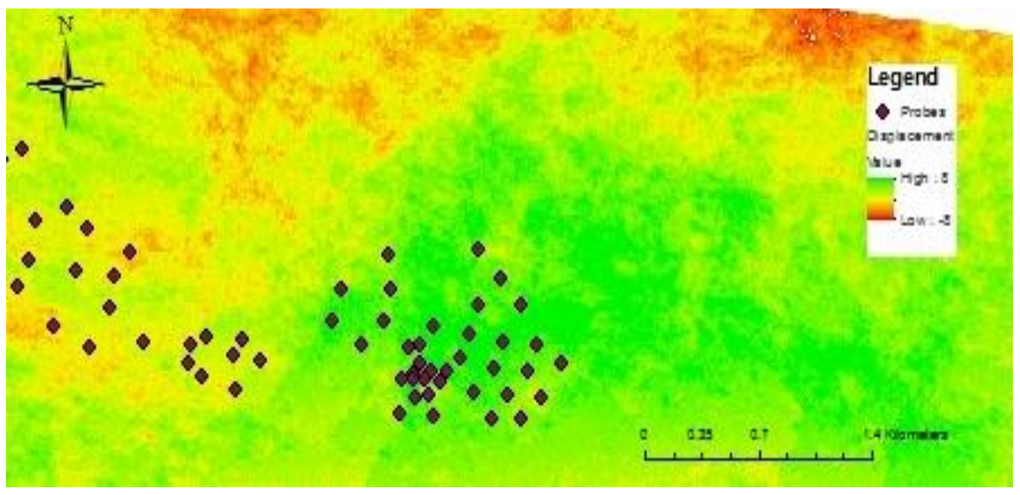

Fig. 4. Deformation map of Ocnele Mari salt mining area derived from TS-X imagery from 18.05-03.08.2011

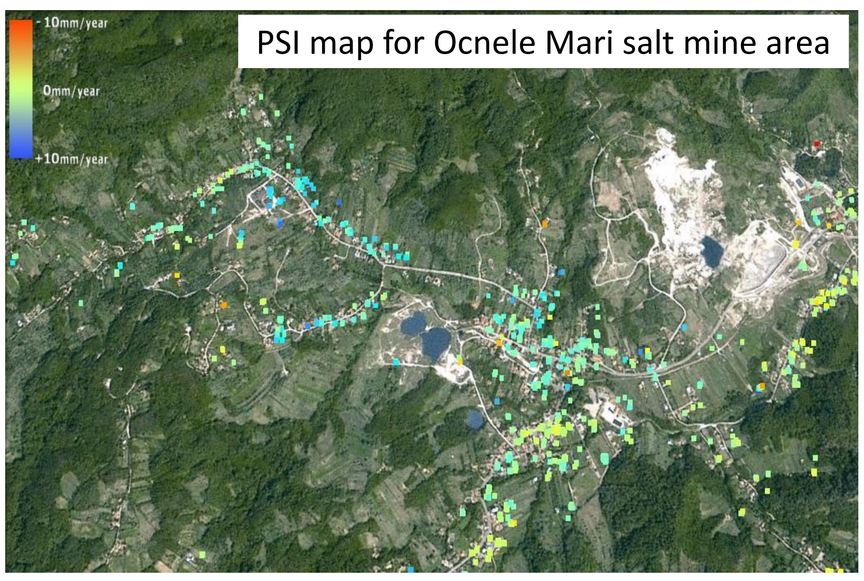

Fig. 5 PSInSAR analysis

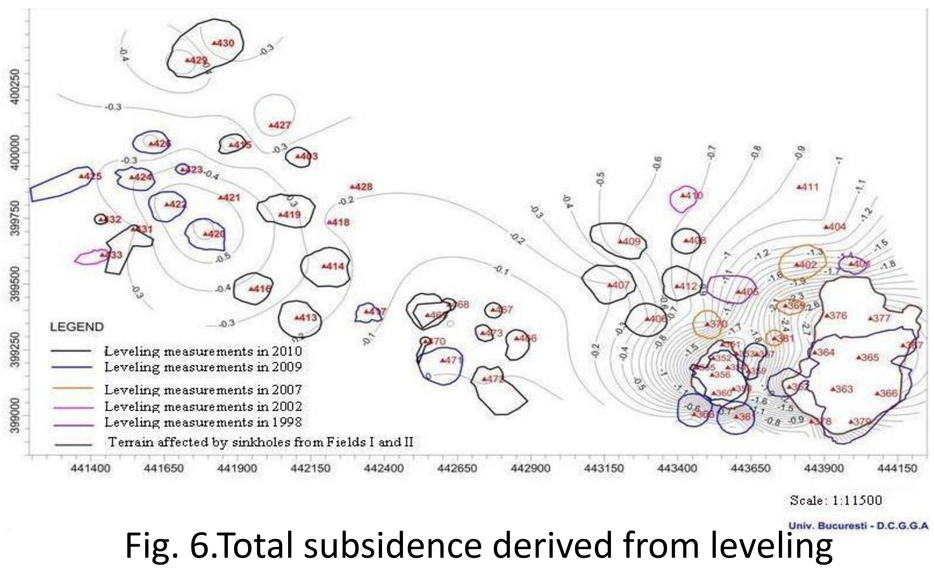

Fig. 6.Total subsidence derived from leveling measurements(Zamfirescu & Mocuta, 2010)

Conclusions

The interferometric measurements confirms the InSAR, DInSAR and PSInSAR techniques feasibilities in a natural landscape. However, the PSInSAR is more appropriate and most suitable for the study of specific area / environment due to main advantages: filtering out of the atmospheric effects and elimination of the temporal and geometrical deccorelation.

Acknowledgements

The interferometric processing was partly performed with SarScape software from Exelis under ESRI Romania one month free licence and works at the ESRI Headquarters.

TerraSAR-X image data were acquired within the TerraSAR-X proposal LAN0778 submitted to DLR in 2010.