Monitoring Urban Subsidence in Bucharest City with TerraSAR-X

Valentin PONCOS [1], Delia TELEAGA [1], Carmen PATRASCU [2], Mihai DATCU [2, 3]

[1]Advanced Studies and Research Center (ASRC), Bucharest, Romania
[2] Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University Bucharest, Romania
[3] Remote Sensing Technology Institute, German Aerospace Center DLR Oberpfaffenhofen, Germany
valentin.poncos@asrc.ro, delia.teleaga@asrc.ro, cpatrascu@ceospacetech.pub.ro, mihai.datcu@dlr.de

Introduction

This work focuses on monitoring the ground motion and infrastructure stability in an urban environment, namely in the city of Bucharest. The city is located in the southeast of Romania and covers an urban area of about 285 km2. Due to its position on the banks of Dambovita River and high underground water levels, the risk of subsidence in the area is significant. Moreover, its closeness to Vrancea seismic area increases the risk of seismic induced deformation in the area. Bucharest is a fast developing city with the average construction rate of 8-20% new buildings with respect to the existing ones. Consequently, the civil engineering industry faced new challenges related to the need of having taller buildings with deeper underground levels, a developing network of subway lines and more bridges with large diameter pilars' foundations. All these new works have an important impact upon the upper ground stability.

Fig. 1 Location of the region of interest

Method and Results

DInSAR, stacking and PSI techniques are used to extract the ground deformation in Bucharest. Multiple interferogram combinations and least squares estimation of deformation will be used in order to attenuate the atmospheric effects. Also, through small baseline stacking, interferograms stacks with different maximum baselines are created in order to estimate if residual topographic errors are still a factor affecting the deformation maps.
The data acquired up to now for processing consists in 32 SLC TerraSAR-X images acquired in Stripmap mode, acquired between July 2011 – December 2012. The interest region was imaged with 11 days repetition cycles, with only a few acquisitions separated by a 33 days interval. All images are acquired using a descending orbit and HH polarization.

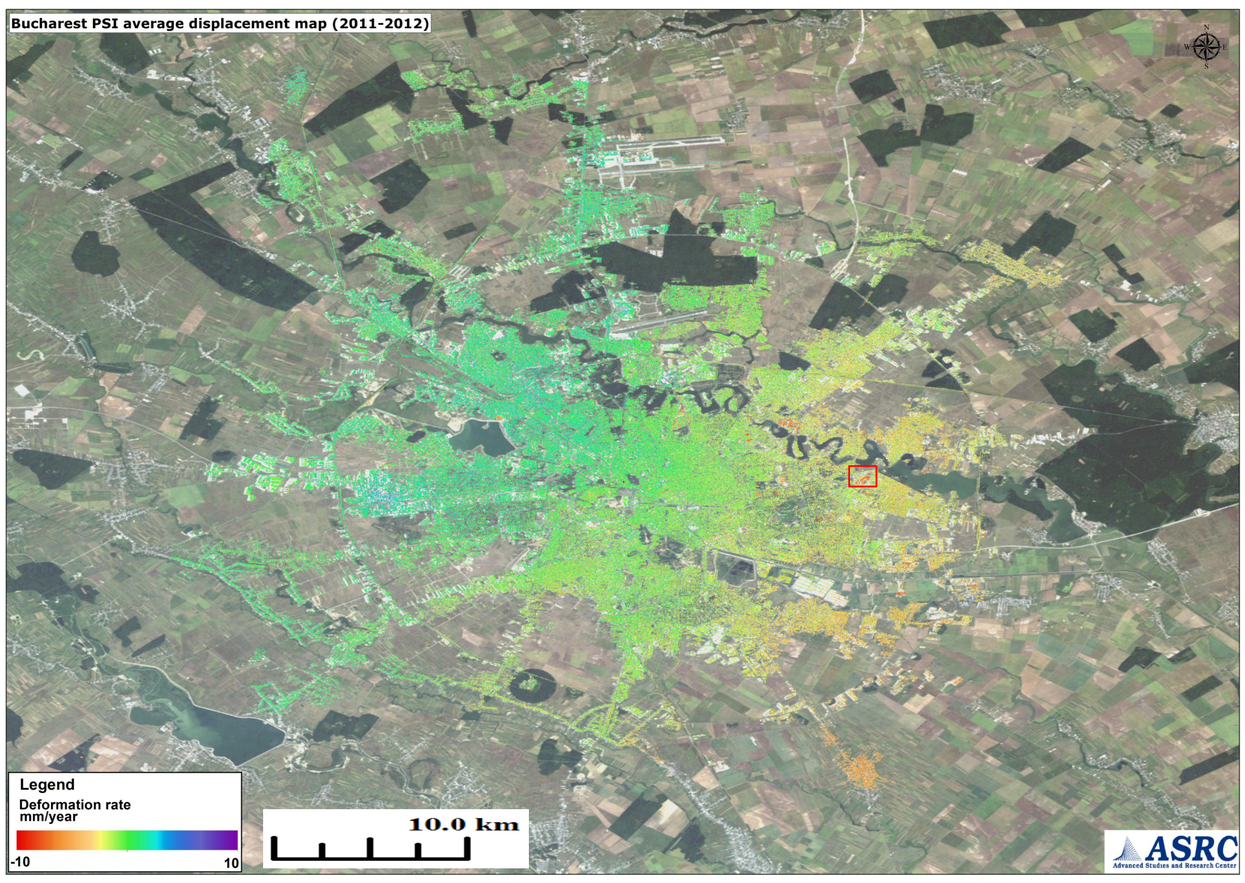

Fig. 2 Preliminary geocoded PSI deformation map of Bucharest city, showing average displacements rates per year. It may be noticed a gradient of the deformation rates from West to East on the entire area. It has to be investigated if this is due to residual atmosphere or it really exists this phenomenon at small scale in Bucharest area.

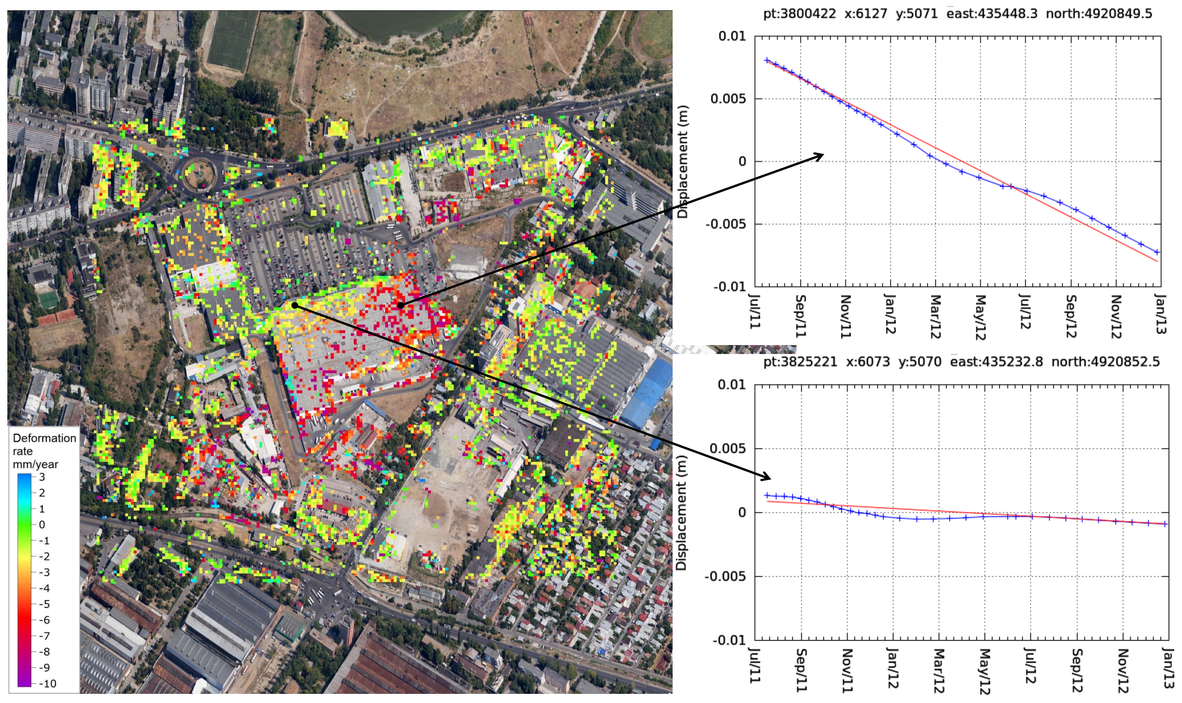

Fig. 3 Strong subsidence of more than 10 mm / year identified on an small area (the red area has a length of about 600 m) in the East part of Bucharest, where a supermarket belonging to a big retail group is build on.
The left picture shows average deformation rates per year, while the graphics on the right side show deformation profiles on two points; the first being affected of clear subsidence and the latter being rather stable.
The building is already affected, cracks appeared in the walls, but the reason is still not clear.

Fig. 4 Zoom-in view of the PSI deformation map on the central part of Bucharest; local subsidence and uplift areas may be identified, but also stable ones. Two examples are given in Figures 5 and 6.

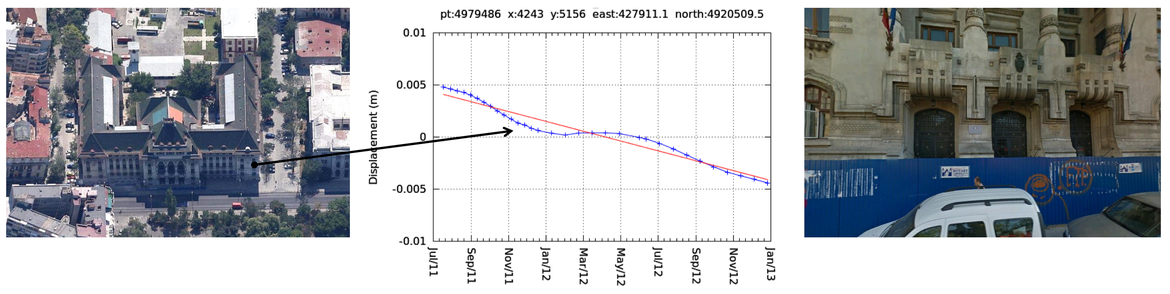

Fig. 5 Temporal deformation profile of a point located on a beautiful old building (dates since1906), where the Bucharest City Hall was hosted until 2010.
Today the building is closed due to consolidation needs.

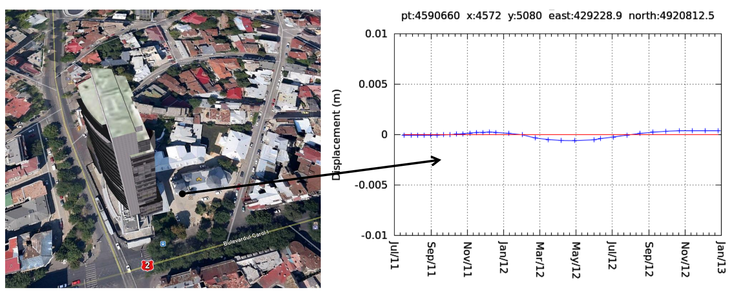

Fig. 6 Deformation profile of a point located near an office building with 19 floors, completed in 2006, in the close proximity of an historic monument. At that moment there was a strong controversy about its stability.

Conclusions and Further Work

A stability analysis of the Bucharest area has been performed, consisting of deformation rates and displacement time series profiles modeled through PS Interferometry. Acquisition of TerraSAR-X data will be continued and the results will be correlated with geological and geophysical information.

Acknowledgements

This work has been conducted in the frame of the Exploratory Research Project PNCDI-II DGI-SAR Spaceborne Multiple Aperture and Sequenial Patterns Extraction Techniques for Accurate Directional Ground Control and Infrastructure Stability Measurements (PN-II-PT-PCCA-2011-3.2-1448). The work has been partially funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Romanian Ministry of Labour, Family and Social Protection through the Financial Agreement POSDRU/107/1.5/S/76903.
TerraSAR-X data provided by German Aerospace Center (DLR) in the frame of LAN1613 Proposal.