Geophysical Research Abstracts
Vol. 17, EGU2015-10059, 2015
EGU General Assembly 2015

Satellite SAR data assessment for Silk Road archaeological prospection

Fulong Chen (1,2), Rosa Lasaponara (3), Nicola Masini (4), Ruixia Yang (1,2)

(1) Key Laboratory of Digital Earth Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, No. 9 Dengzhuang South Road, Haidian District, Beijing 100094, China, (2) International Centre on Space Technologies for Natural and Cultural Heritage under the Auspices of UNESCO, No. 9 Dengzhuang South Road, Haidian District, Beijing 100094, China, (3) CNR-IMAA (Institute of Methodologies for Environmental Analysis), C.da S. Loya, 85050 Tito (PZ), Italy, (4) IBAM-Istituto per i Beni Archeologici e Monumentali, CNR, Tito Scalo (PZ), Italy (n.masini@ibam.cnr.it)

The development of Synthetic Aperture Radar (SAR) in terms of multi-band, multi-polarization and high-resolution data, favored the application of this technology also in archaeology [1]. Different approaches based on both single and multitemporal data analysis, exploiting the backscattering and the penetration of radar data, have been used for a number of archaeological sites and landscapes [2-5]. Nevertheless, the capability of this technology in archaeological applications has so far not been fully assessed. It lacks a contribution aimed at evaluating the potential of SAR technology for the same study area by using different bands, spatial resolutions and data processing solutions. In the framework of the Chinese-Italian bilateral project "Smart management of cultural heritage sites in Italy and China: Earth Observation and pilot projects", we addressed some pioneering investigations to assess multi-mode (multi-band, temporal, resolution) satellite SAR data (including X-band TerraSAR, C-band Envisat and L-band ALOS PALSAR) in archaeological prospection of the Silk road [6].
The Silk Road, a series of trade and cultural transmission routes connecting China to Europe, is the witness of civilization and friendship between the East and West dated back to 2000 years ago, that left us various relics (e.g. lost cities) to be uncovered and investigated..
In particular, the assessment has been performed in the Xinjiang and Gansu section pf the Silk Road focusing on :
i) the subsurface penetration capability of SAR data in the arid and semi-arid region
ii) and sensitivity of SAR imaging geometry for the detection of relics
As regards the point i) , apart from the soil moisture, the penetration is seriously restricted by the soil porosity. For instance, negligible penetration signs were detected in Yumen Frontier Pass either using X- or L-band SAR data due to the occurrence of Yardang landscape.
As regards the point ii), the flight path of SAR images in parallel with the direction of observed targets is beneficial for improved detection of potential linear remains (e.g. Great Wall in Han-dynasty surrounding the Yumen Frontier Pass) owing to the formation of dihedral and helix scatterings based on the theory of radar physics.
Morevorer, spatial resolution of multi-mode SAR images for archaeology was compared in the sites of Niya, Yumen Frontier Pass and suspected protectorate of the western regions. Results indicated that high resolution tended to easier detection of ancient targets through the identification of backscattering anomalies.
Finally, interferometric analysis was also evaluated to provide complementary information rather than the backscattering. The variation of coherence is closely related to the physical parameters of observed surface, e.g. soil moisture, mild-relief as well as materials; and consequently it is useful for the relic feature enhancement and identification, validated by the PALSAR coherence images in Niya site.

Acknowledgement
This research was performed within the framework of the project "Smart management of cultural heritage sites in Italy and China: Earth Observation and pilot projects", funded by the Italian Ministry of Foreign Affairs and the Hundred Talents Program of the Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences (Y2ZZ27101B). The PALSAR data were provided by the European Space Agency to the authors through the Category-1 Project Id. 28640.

Reference
[1] Lasaponara R., Masini N. 2013, Satellite Synthetic Aperture Radar in Archaeology and Cultural Landscape: An Overview. Archaeological Prospection, 20, 71-78, doi: 10.1002/arp.1452
[2] Chen F., Masini N., Yang R., Milillo P., Feng D., Lasaponara R., 2015 A Space View of Radar Archaeological Marks: First Applications of COSMO-SkyMed X-Band Data. Remote Sens. 2015, 7, 24-50; doi:10.3390/rs70100024.

[3] Cigna, F.; Tapete, D.; Lasaponara, R.; Masini, N. Amplitude change detection with Envisat ASAR to image the cultural landscape of the Nasca region, Peru. Archaeological Prospection 2013, 20, 117-131
[4] Stewart C., Di Iorio A., Schiavon G., Analysis of the utility of Cosmo Skymed stripmap to detect buried archaeological features in the region of Rome. Experimental component of WHERE project. In Lasaponara R., Masini N., Biscione M. (Eds), Earth Observation and Social Perspectives. Towards Horizon 2020. Proceedings of the 33rd EARSeL Symposium. Matera (Italy), 3-6 June 2013. EARSeL and CNR publisher, 2013, pp. 203-212, ISBN 978-88-89693-34-6
[5] Tapete D., Cigna F., Masini N., Lasaponara R. 2013. Prospection and monitoring of the archaeological heritage of Nasca, Peru, with ENVISAT ASAR, Archaeological Prospection, 20, 133-147, doi: 10.1002/arp.1449.
[6] Chen, F.; Gabellone, F.; Lasaponara, R.; Leucci, G.; Masini, N.; Yang, R. Remote Sensing and ICT for Cultural Heritage from European and Chinese Perspectives. Series "Along Silk Road", 1, Publishers CNR-IBAM, CNR-IMAA and CAS, Potenza, 2013, ISBN 9788889693230