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Satellite SAR imagery for site discovery, change detection and monitoring activities in cultural heritage sites: experiments on the Nasca region, Peru

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Besides their suitability for multi-temporal and spatial deformation analysis, the Synthetic Aperture Radar (SAR) image archives acquired by space-borne radar sensors can be exploited to support archaeological investigations over huge sites, even those partially or totally buried and still to be excavated. Amplitude information is one of the main properties of SAR data from which it is possible to retrieve evidences of buried structures, using feature extraction and texture analysis. Multi-temporality allows the reconstruction of past and recent evolution of both landscape and built-up environment, with the possibility to detect natural and/or anthropogenic changes, including human-induced damages to the conservation of cultural heritage.

We present the methodology and first results of the experiments currently undertaken using SAR data in the Nasca region (Southern Peru), where two important civilizations such as Paracas and Nasca developed and flourished from 4th century BC to the 6th century AD. The study areas include a wide spectrum of archaeological and environmental elements to be preserved, among which: the archaeological site of Cahuachi and its surroundings, considered the largest adobe Ceremonial Centre in the World; the Nasca lines and geoglyphs in the areas of Palpa, Atarco and Nasca; the ancient networks of aqueducts and drainage galleries in the Puquios area, built by Nasca in the 1st-6th centuries AD.

Archaeological prospection and multi-purpose remote sensing activities are currently carried out in the framework of the Italian mission of heritage Conservation and Archaeogeophysics (ITACA), with the direct involvement of researchers from the Institute for Archaeological and Monumental Heritage and the Institute of Methodologies for Environmental Analysis, Italian National Research Council.

In this context, C- and L-band SAR images covering the Nasca region since 2001 were identified for the purposes of this research and, in particular, the following data stacks were selected: ERS-2 ascending data acquired in 2001-2011, ENVISAT ASAR ascending and descending data acquired in 2003-2007, and ALOS PALSAR descending and ascending data acquired in 2007 and 2008.

The feature extraction was specifically addressed to the recognition of buried structures, archaeological deposits and the study of the buried networks of aqueducts, as well as the morphological study of the Nasca geoglyphs. Change detection analysis also included the multi-temporal reconstruction of the evolution of the Rio Nasca catchment basin, while specific tests were performed to demonstrate the usefulness of SAR imagery for monitoring looting activities.

The results of the radar-interpretation compared and integrated with the field investigations will support the archaeological activities and contribute to the monitoring and enhancement of archaeological heritage and cultural landscape of the Nasca region.