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Environmental evolution of the Rio Grande drainage basin and Nasca region (Peru) in 2003-2007 using ENVISAT ASAR and ASTER time series

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Recent palaeo-environmental studies and remote sensing investigations demonstrated that the Rio Grande drainage basin in Southern Peru is a still evolving landscape, and impacts due to its changes have implications for the preservation of both the natural and cultural features of the Nasca region, well-known for the evidences of the ancient Paracas and Nasca Civilizations, who flourished from the 4th century BC to the 6th century AD. To image the modifications occurred in the last decade, we exploited the entire 4year-long stack of ENVISAT ASAR C-band archive imagery available over the region, which was provided by the European Space Agency (ESA) via the Cat-1 project 11073. The latter supports the activities of the Italian mission of heritage Conservation and Archaeogeophysics (ITACA), which directly involve researchers from the Institute for Archaeological and Monumental Heritage (IBAM) and the Institute of Methodologies for Environmental Analysis (IMAA), National Research Council (CNR) of Italy. With the aim of reconstructing the temporal evolution of the Rio Grande drainage basin and its effects and implications for the heritage of the region, we processed 8 ASAR Image Mode IS2 scenes acquired in descending mode between 04/02/2003 and 15/11/2005 and 5 images in ascending mode between 24/07/2005 and 11/11/2007, and focused on SAR backscattering information, amplitude change detection methods and extraction of ASAR-derived time series of the backscattering coefficient over target areas of interest. The ASAR 2003-2007 analysis was coupled and integrated with NDVI-based soil moisture and vegetation change assessment performed by using ASTER multi-spectral data acquired during the same time frame of the ASAR stacks, on 30/05/2003, 01/06/2004 and 10/06/2007. The research was performed both at the regional scale over the entire Rio Grande drainage basin, with particular focus on its tributaries Rio Ingenio, Rio Nazca and Rio Taruga, and at the local scale over the Nasca Puquios, ancient networks of open trenches and/or subterranean galleries (puquios) which provided and in many case still provide a source of irrigation water. The analyzed area included the large dry hydrographic reticulum lying within the desert south of the Rio Nazca, and both functioning and disused puquios were identified and analyzed within the ASAR and ASTER imagery and their derived products. Among others, we focused on the Santa María, San Carlos and Camotal puquios within the Rio Taruga valley. Multi-temporal observations of agricultural/vegetated areas were highly helpful to understand the environmental scenario, its evolution and mutual interactions with presence and development of ancient civilizations within the river basin. Croplands tend to adapt to water availability and its fluctuations over time, thereby changing very rapidly, and act as a reliable indicator of the presence of groundwater. Both optical and radar image stacks help drawing a clearer picture of the recent and present hydraulic regime of the rivers within the Nasca region. This environmental assessment can also support and provide benefit for archaeological studies, based on the identification of surface indicators which can be correlated to buried cultural features, such as ancient but still functioning puquios.

References

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