



Multitemporal analysis and archaeogeophysical methods to monitor and face the archaeological looting: the experience in Nasca (Southern, Peru)

Nicola Masini (1), Maria Danese (1), Rosa Lasaponara (2), and Giuseppe Orefici (3)

(1) IBAM-Istituto per i Beni Archeologici e Monumentali, CNR, Tito Scalo (PZ), Italy (n.masini@ibam.cnr.it, ++390971427333), (2) IMAA-Istituto di Metodologie di Analisi Ambientale, CNR, Tito Scalo (PZ), Italy, (3) CISRAP (Centro de Estudios Arqueológicos Precolombinos), Nasca, Peru

In several countries of Southern America, Asia and Middle East looting and clandestine excavations affect archaeological heritage more than other man-made and natural risks. These activities are mainly linked to illicit trade of antiquities mainly in Europe and North America.

In order to contrast this phenomenon, since 1956 the General Conference of the UNESCO recommended all the Member States to take "all necessary measures to prevent clandestine excavations and damage to monuments .and also to prevent the export of objects thus obtained"[1].

The looting phenomenon is much more dramatic in events of armed conflicts, as occurred in Iraq during the two Gulf Wars [2]. In spite of a new ethical environment against the acquisition of unprovenanced antiquities [3] much more must be made to contrast the looting which increasingly affects archaeological sites all over the world.

In many countries the monitoring of clandestine is carried out by using aerial survey. Unfortunately, aerial surveillance is time consuming and little effective for huge areas and for difficult environmental settings. Moreover, it is prevented in those countries where aerial flights are strongly restricted for political reasons or due to armed conflicts.

In these conditions, Very high resolution (VHR) satellite images (GeoEye, WorldView1-2, QuickBird2, Ikonos) offer a suitable chance thanks to their global coverage and frequent revisit times, as some recent experiences carried out in the Middle East proved in recent times [4].

Since 2007, within the scientific activity of ITACA (Italian mission of heritage Conservation and Archaeogeophysics), two institutes of the Italian CNR are experiencing VHR satellite data to support archaeological investigations as well as to analyze and monitor archaeological looting in the Nasca Region (Southern, Peru) [5-8]. The main archaeological resources in this region are the monumental pyramids and around forty semi-artificial mounds of the ceremonial Centre of Cahuachi (400 B.C. – 400 A.D..) linked to the Nasca civilization and the famous geoglyphs listed in the World Heritage, located on the tablelands of the River Nasca drainage basin.

As for many other Pre-Colombian civilization of Southern America, also for the Nasca the ceremonial activity was crucial in order to propitiate the gods, have rich harvests and prevent natural disasters. Due to the intense ceremonial activity of Nasca from the 2nd to the 5th century AD, the subsoil of Cahuachi and its surrounding stored up an enormous quantity of precious offerings and rich tombs which have been very tempting target for looters since the 19th century.

A time series of panchromatic and multispectral satellite images allowed the mapping of looting over the last ten years. The reliability of the detection was evaluated by field surveys carried out on some test sites. The evaluation has shown a rate of success was very high in some areas and unsatisfactory for other areas. This suggested to experience different data processing methods. The paper shows the results obtained by means of an approach based on local spatial autocorrelation statistics.

- [1] UNESCO 1956, Recommendation on International Principles Applicable to Archaeological Excavations
- [2] Stone E. C.(2007). Patterns of looting in southern Iraq. *Antiquity* 82 (2008) 125-138.
- [3] UNESCO (1970). Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property
- [4] Parcak S. (2007). Satellite remote sensing methods for monitoring archaeological tells in the Middle East. *Journal of field archaeology* 32 (1), 65-81.
- [5]. Masini N., Lasaponara R., Orefici G. (2009). Addressing the challenge of detecting archaeological adobe structures in Southern Peru using QuickBird imagery, *Journal of Cultural Heritage*, 10S, e3-e9 [doi:10.1016/j.culher.2009.10.005]

- [6] Rizzo E., Masini N., Lasaponara R., Orefici G. (2010). ArchaeoGeophysical methods in the Templo del Escalonado (Cahuachi, Nasca, Perù), *Near Surface Geophysics*, 8, 433-439, [doi:10.3997/1873-0604.2010030].
- [7] Lasaponara R., Masini N., Rizzo E., Coluzzi R., Orefici G. (2011). New discoveries in the Piramide Naranjada in Cahuachi (Peru) using satellite, Ground Probing Radar and magnetic investigations. *Journal of Archaeological Science*, doi:10.1016/j.jas.2010.12.010
- [8] Masini N., Lasaponara R. (2010). Facing the archaeological looting in Peru by local spatial autocorrelation statistics of Very high resolution satellite imagery, *Proceedings of ICSSA, The 2010 International Conference on Computational Science and its Application* (Fukuoka-Japan, March 23 – 26, 2010), David Taniar, Osvaldo Gervasi, Beniamino Murgante, Eric Pardede, Bernady O. Apduhan (Ed.), Springer, Berlin, 2010, pp. 261-269.