

## Proceeding Paper

# Geomorphological Analysis in an Open-Source GIS for a Context of Peri-Urban Archaeology: The Medieval Settlement of San Lorenzo in Carmignano (Foggia, Italy) <sup>†</sup>

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**Abstract:** The archaeological investigations conducted at the medieval site of San Lorenzo in Carmignano, just outside the city of Foggia, Italy, fall within a broader context of archaeological research on earthworks in the Middle Ages, in the area of the Tavoliere plain. The settlement is attested as a *casale* since 1092, in 1166 it was classified as a *castrum*, until the Late Medieval abandonment. Evident traces of ditches and embankments, over an area of over 25 ha, were already visible in the aerial photos, taken during the Second World War by British military aircrafts and analysed by J. Bradford. Since 2005, stratigraphic excavations have been undertaken by the Department of Humanities of the University of Foggia and, more recently, it has been possible to obtain satellite images and high-resolution digital models of the land from satellite data, orienting research on the analysis of micro-relief, aimed at finding the traces relating to the earth fortifications still perceptible on the site. The integration between the data obtained from modern satellite images and those returned by the pioneering archaeological aerial photography of the 40 s of the last century allowed to shed new light on a relevant settlement in the context of the landscape and medieval population of northern Puglia.

**Keywords:** GIS; DTM; satellite; earthworks; enclosures; medieval; settlement



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## 1. Introduction

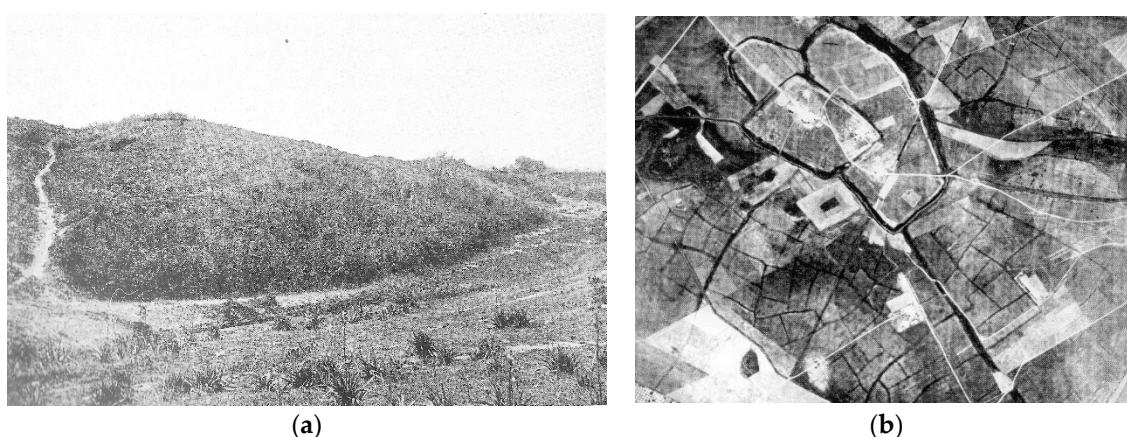
The research aims to represent an example of use in archaeological sense of digital terrain models (DTM), from satellite data; these models, in fact, can be used to study the geomorphology, the micro-relief, and the configurations of surfaces and soil, in order to reconstruct the characteristics of ancient, disappeared settlements and landscapes.

The case-study selected to experiment and verify these research possibilities is constituted by the site of San Lorenzo in *Carminiano*, a deserted medieval settlement, located in Tavoliere, the Apulian plain; actually, the settlement now incorporated in the outskirts of the city of Foggia (provincial capital).

San Lorenzo was mentioned in the sources, for the first time, in 1092, as *casale*, i.e., rural village (about written sources regarding the site, see [1]). The site arose, between the late Byzantine Age and the Norman era, as one of the agricultural poles for the exploitation of the resources of the plain. Enlarged and equipped with more strong elements of defence (in 1167, San Lorenzo was qualified as *castrum*), the town still played an important role in the productive geography of the region along the 13th and first part of 14th century. It was then involved in the process that led to the disappearance of many settlements in Tavoliere, between Late Medieval Ages and Early Modern Times.

From a strictly archaeological point of view, the site was identified through a pioneering survey, carried out by the German researcher Arthur Haseloff, at the beginning of the 20th century. The plan drawn by Haseloff reproduces a settlement divided into

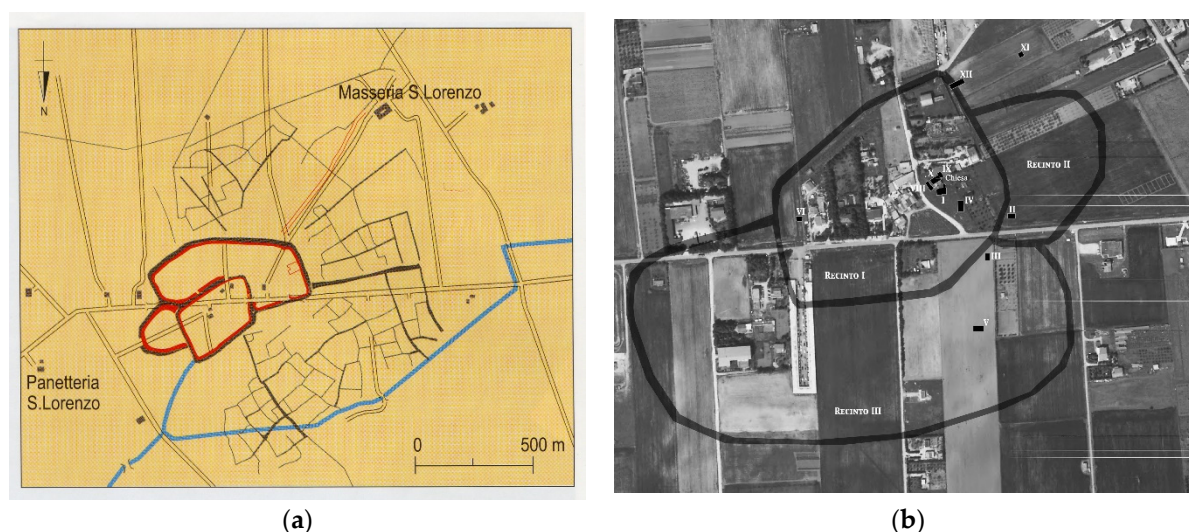
three, connected but distinct, enclosures, surrounded by ditches and embankments: the topography of the settlements was articulated in a Northern enclosure, approximately trapezoidal (it still preserves inside the architecture of an ancient church), in a smaller semi-circular one, located in north-eastern side, and in a third, much larger and elliptical space, occupying the southern part of the site. About a century ago, Hasselhoff was still able to measure the width of 20 m and the height of 5 m of the earthwork and the width of 10 m of the trench [2] (pp. 84–85, fig. 6–7) reproducing them photographically (Figure 1a).



**Figure 1.** (a) Particular of earthwork of San Lorenzo, at the beginning of 20th century (from [2]). (b) Aerial photo of San Lorenzo in 1943 (from [3]).

In 1943, during the Second World War, the Royal Air Force unleashed an aerial photography of San Lorenzo, published by John Bradford [3], pl. Vb, [4], (pp. 93–94). The aerial shot (another example of pioneering application of an archaeological method in Italy) confirmed substantially the Hasselhoff's reconstruction (Figure 1b), allowing to recompose the topographic characteristics of the settlement, as a whole, and to specify its dimension: San Lorenzo therefore extended for 26.6 ha (northern enclosure 8.5 ha; north-eastern enclosure: 3.1 ha; southern enclosure: 15 ha).

Still in the aerial photo from 1954 and 1958, the settlement appeared part of a totally rural area (Figure 2a): the ditches and embankments and also the traces of roads, houses, and agricultural partition was clearly visible [4] (p. 923, pl. XXXVII), [5] (p. 157, fig. 217–218).



**Figure 2.** (a) Graphic interpretation of aerial view of San Lorenzo (from [5]). (b): Aerial photo of San Lorenzo, with localization of archaeological trenches (photo: University of Foggia, Department of Humanities).

The large land reclamations of the second half of the 20th century, linked with the disorderly building expansion of the outskirts of Foggia, have completely changed the configurations of the site's soils, as evidenced by the most recent aerial photos [6].

The archaeological excavations carried out in the years 2005–2006 and 2009 in San Lorenzo (Figure 2b) have achieved important results [7]: the investigation of remains attributable to a Late Antique and Early Medieval occupation of the area; acquisition of data regarding the Medieval phase of the church in northern enclosure; discovery of remains of Medieval burials, houses, and grain silos; identification of great southern enclosure as the *suburbium* mentioned in written sources in 1199.

The excavation intercepted parts and sections of the trenches surrounded the settlement but had to register the cancellation or the flattening of the rest of the earthworks; so, it is not possible to verify whether the embankments were completed by wooden fences, or earth structures, or stone walls.

We tried to answer this gap through a use of the DTM, the analysis of the micro-relief, and the tracing of topographic sections in a Q-GIS ambient; in this way, it was possible to recover some archaeological elements, regarding geomorphology, soil, and earthwork of San Lorenzo in Carminiano, which have widely lost in the last century.

## 2. Materials and Methods

For the selected area, it was considered appropriate to acquire a database consisting of satellite images, on which to conduct *inter-site* and *intra-site* spatial analyses. The choice fell on images acquired in November 2015 by the GeoEye-1 satellite over an area of approximately 25 km<sup>2</sup>. It is a sun-synchronous (SSO) polar orbit satellite, capable of making 15 orbits per day, flying at an altitude of 681 km, with a speed of about 7.5 km/s and an inclination of 98°. Its characteristics allow it to pass over the same point of the globe in just under 3 days.

## 3. Discussion

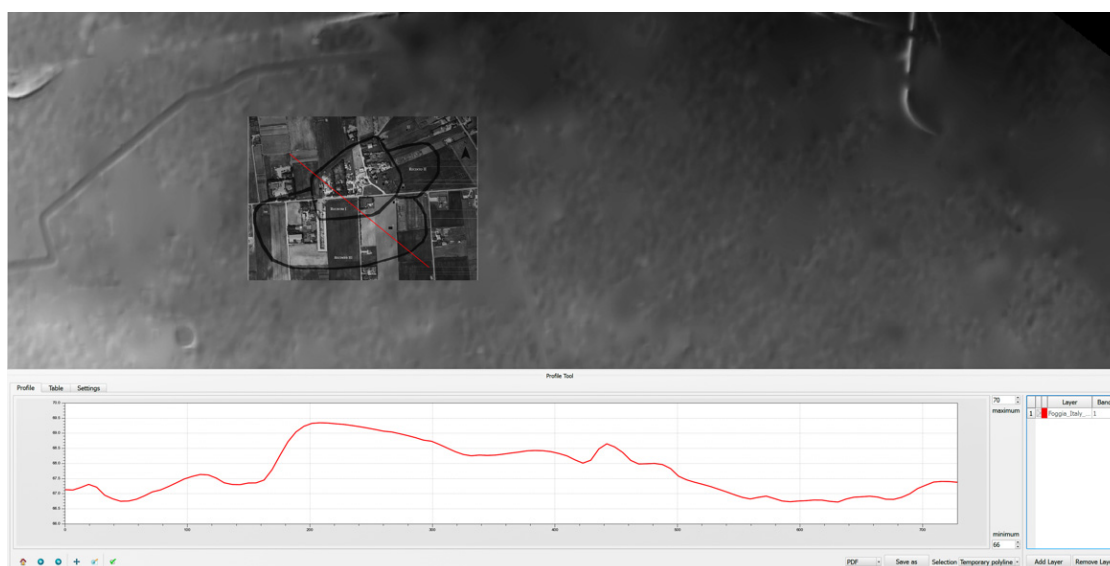
The geomorphological analysis of the defensive systems of the medieval settlement of San Lorenzo in Carmignano was conducted on the basis of a 5 m resolution digital terrain model, from the GeoEye-1 Satellite sensor. The aim was to rediscover the possible persistence of traces of the moats and earthworks that surrounded the settlement, in particular with reference to its designation with the term *castrum*, towards the middle of the 12th century [1] (p. 66).

Two topographic section profiles of the DTM were traced in a GIS environment (Quantum GIS, with the Terrain Profile plugin), with north–west/south–east and north–east/south–west orientation (Figures 3 and 4), intercepting the limits of the medieval settlement, already hypothesized by J. Bradford and J. M. Martin [1,2].

The North–west/south–east profile highlights the morphology of the hill (the northern enclosure) on which the late 11th century *casale* was probably founded [1] (p. 66). It is not excluded that the artificial raising was obtained by taking the soil from the trench surrounding the area [1]. The profile also intercepts, in its last stretch, the moat delimiting the southern enclosure, recognized by Martin as the *Suburbium Sancti Nicolai*, mentioned by literary sources, an area with a dense residential occupation already before the beginning of the 13th century [1] (p. 66).

The north–east/south–west profile intercepts, in four points, the ditches relating to the three enclosures that characterize the area (based on the ceramic data) highlighting correspondences between the tracing of the ditches and slight topographical depressions found on the surface of the DTM.





**Figure 3.** North-west/south-east topographic section profile of the area of the medieval settlement of San Lorenzo in Carmignano in a GIS software.



**Figure 4.** North-east/south-west topographic section profile of the area of the medieval settlement of San Lorenzo in Carmignano in a GIS software, highlighting the depressions in the ground corresponding to the traces of the ditches.

**Author Contributions:** Introduction: P.F. Materials and methods; discussion: L.d. All authors have read and agreed to the published version of the manuscript.

## References

1. Martin, J.-M.; Noyé, G.H. L'évolution d'un habitat de plaine jusqu'au XIVe siècle: L'exemple de San Lorenzo in Carminiano. In *Fiorentino. Campagne di Scavo 1984–1985*; Congedo Editore: Galatina, Italy, 1997; pp. 63–78, tavv. LXXXIX–XC.
2. Haseloff, A. *Architettura Sveva Nell'Italia Meridionale*, Italian ed.; Adda Editore: Bari, Italy, 1992; (original German edition: *Die Bauten der Hohenstaufen in Italien*, Leipzig 1920).
3. Bradford, J.P.S. Buried landscape in Southern Italy. *Antiquity* **1949**, *23*, 58–72. [[CrossRef](#)]
4. Bradford, J.P.S. The Apulia Expedition. *Antiquity* **1950**, *24*, 88–95. [[CrossRef](#)]
5. Schmiedt, G. Le fortificazioni altomedievali viste dall'aereo. In *Ordinamenti Militari in Occidente nell'Altomedioevo, Proceedings of the XV Settimana di Studi del CISAM, Spoleto, Italy, 30 March–5 April 1967*; Centro Italiano di Studi sull'Altomedioevo: Spoleto, Italy, 1968; Volume 2, pp. 860–927, tavv. I–XL.

6. Mazzei, M. San Lorenzo in Carmignano. In *Lo Sguardo di Icaro, Le Collezioni dell'Aerofototeca Nazionale per la Conoscenza del Territorio (Catalogo della Mostra)*; Guaitoli, M., Ed.; Campisano Editore: Roma, Italy, 2003; pp. 115–117, figg. 217–218.
7. Favia, P.; Annese, C.; De Stefano, A.; De Venuto, G.; Di Zanni, A.; Maruotti, M.; Pierno, M.; Stoico, F. San Lorenzo “in Carminiano” presso Foggia: Indagine archeologica su un sito medievale del Tavoliere di Puglia in un contesto di moderna espansione edilizia. In *Proceedings of the V Convegno Nazionale della Società degli Archeologi Medievisti Italiani*, Manfredonia, Italy, 30 September–3 October 2009; Edizioni All’Insegna del Giglio: Borgo San Lorenzo, Italy, 2009; pp. 382–391.