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From remote sensing to a serious game: Digital reconstruction of an abandoned medieval village in Southern Italy

Francesco Gabellone [a], Antonio Lanorte [b,*], Nicola Masini [c], Rosa Lasaponara [b]

[a] Institute for Archaeological and Monumental Heritage, National Research Council, Campus Monteroni, 73100 Lecce, Italy
[b] Institute of Methodologies for Environmental Analysis, National Research Council, C.da Santa Loja, 85050 Tito Scalo (PZ), Italy
[c] Institute for Archaeological and Monumental Heritage, National Research Council, C. da S. Loya, 85050 Tito Scalo (PZ), Italy

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ABSTRACT

The digital reconstruction of the history of a buried medieval village is the main focus of this paper. The study, based on remote sensing and historical sources, is the starting point of the development of a serious game aimed at educational purposes and exploitation of remote sensing data in the field of edutainment. The selected historical scenario is Yrsum, a village in Basilicata (South of Italy), founded in the 11th century and abandoned in the 14th century. A LiDAR survey along with satellite multispectral data (suitably elaborated for feature extraction) as well as the historical sources and archaeological records provided useful information on the 'forma urbis' of the medieval settlement from its foundation to its abandonment. The extraction of the archaeological features and the analysis of urban pattern put in evidence similarities with some medieval settlements based on "motte and bailey" typology that spread in Southern Italy, France and England from the 11th to the 13th century. After the virtual reconstruction, an interactive application articulated both on bi-dimensional and three-dimensional elements have been developed. The major novelty compared to most common video games has been the possibility to derive the game from rigorously scientific data. The player enjoys and learns within a logic of an edutainment game (a combination of education and entertainment), which has become by now a well-established concept but still rarely applied in the field of cultural heritage.

1. Research aims

This article deals with the virtual reconstruction of the history of a buried medieval village used as a starting point for the development of a serious game. This is a hot issue for historians, archaeologists and computer science communities among them active debates have been recently engaged on the questions of how computer science can enable a better understanding of the past.

Although the dramatic advances achieved in the field of computer science and technologies for archaeology, still today the joint use of virtual reconstruction, remote sensing data and serious gaming tools is not fully exploited to support enhancing museum visits and learning purposes. In case of the impossibility of digging and restoring, due to the high costs, these technological tools can provide relevant support for:

- a virtual reconstruction/restoration giving to the viewer a sense and feel of how the original was;
- a creation of a virtual replica of the original;
- enriching the information on the past environments and sites;
- capturing the visitors' attention, making them active players and "actors".

2. Introduction

The field of digital archaeology is stepping in its golden age characterized by an increasing growth of both classical and emerging multidisciplinary methodologies, addressed to the study and conservation of archaeological heritage. The availability of the new digital technologies have opened, for the cultural heritage, new possibilities unthinkable only a few years ago.

The impact of digital technologies for archaeology regards researchers, professionals as well as end-users. This is clearly evident thinking about, for example, the new portable devices, as tablets and smart-phones, nowadays equipped with integrated GPS, very powerful processors and video cards, which permit us

* Corresponding author.
E-mail address: antonio.lanorte@imaa.cnr.it (A. Lanorte).

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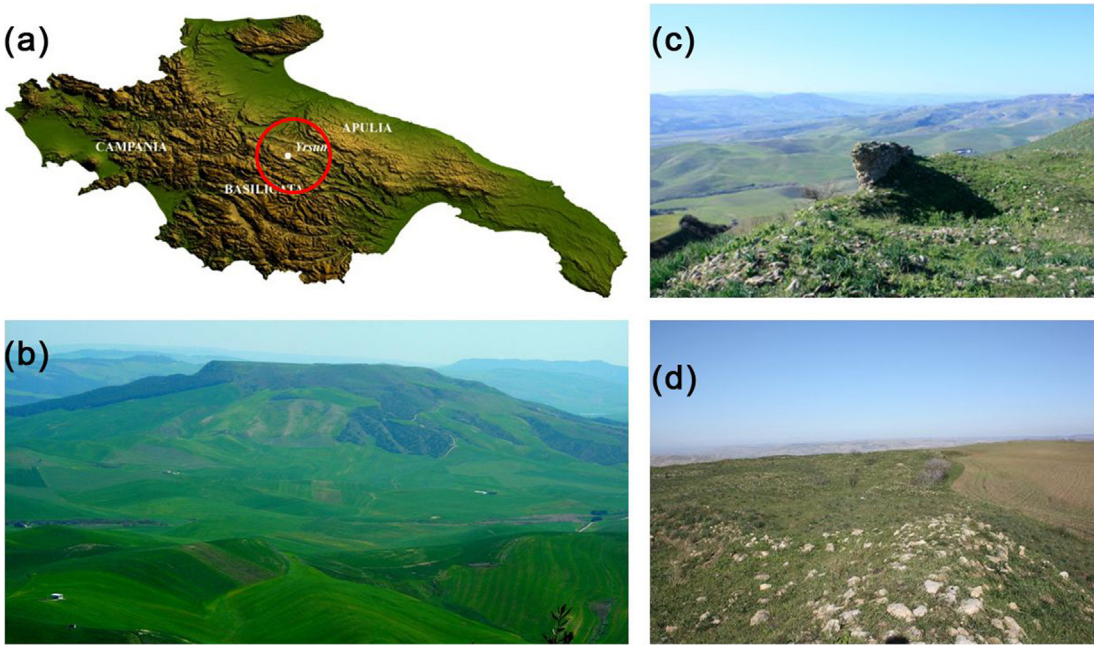

Fig. 1. a: location of *Yrsum*; b: panoramic view of the hilly plateau where *Yrsum* was built; c: ruins of the castle; d: details of some walls of the medieval village.

to enjoy virtual reconstructions and an increasing amount of information available "exactly on-site and on time".

The digital tools nowadays available for archaeology enable us to get extremely precise results speeding up the work during the diverse phases of archaeological investigations ranging from survey, mapping, excavation, documentation, exploitation and monitoring at diverse scales of interest, moving from small artifacts to architectural evidences and landscape reconstruction.

In the case of lack of direct data coming from archaeological excavations, as in Yrsum, the current case under investigation, a possible strategy to reconstruct the history of the site and its surrounding landscape, could be based on remote sensing, historical sources and field survey. Remote sensing technologies coupled with computer science can enable a better understanding of the past, also for non-experts, providing realistic image of historic buildings and monuments, which are now in ruins, as well as allowing a virtual reconstruction of non-excavated sites. One of the main greatest advantages of digital technologies is that they gather an immense amount of information on archaeological remains, even buried, in a non-invasive, also protecting and preserving them. A virtual reconstruction/restoration gives a sense and feel of how the original was, creating a virtual replica of the original.

In this paper, we provide a reconstruction of the medieval village of Yrsum located near Matera (South of Italy). It was founded in the 11th century and later abandoned in the 14th century (Fig. 1).

The analysis and interpretation of orthophotos and digital elevation models based on LiDAR and satellite data along with the study of historical sources and the available archaeological records, provided useful information on the '*forma urbis*' of the medieval settlement from its foundation to its abandonment. The analysis of urban pattern put in evidence similarities with settlements based on "motte and bailey" typology. The latter characterized medieval fortified sites of Southern Italy, France and England from the 11th to the 13th century (Fig. 2). After the virtual reconstruction, an interactive application (*Yrsum* game) articulated both on bi-dimensional and three-dimensional elements have been developed. The major novelty compared to most common video games has been the possibility to derive the game from rigorously scientific data [1].

The serious game is an interactive virtual simulation of real-world events or processes. Although it can be entertaining, its main purpose is to train or educate users for different "serious" applications addressed to defence, business, industry, city planning, emergency management, education, scientific investigations and cultural heritage [2–4].

The serious game is generally designed to develop skills and competencies to be applied in the real-world through the exercise in a simulated and protected environment. By playing real-life situations, participants achieve a goal through the use of specific knowledge and the implementation of strategies. The information and sensations experienced are strongly imprinted and thus allow the player exercise in a simulated and protected environment through "learning by doing", with the advantage, however, to act in the protected area of a simulation software.

The game increases the involvement and allows us to act more spontaneously. The ability to repeat the exercise many times allows full mastery of explored dynamics by increasing the confidence with which the tool is used and with whom it will deal with the real situation.

Among the serious games, the edutainment, a combination of education and entertainment, has been strongly increasing. The term edutainment is a neologism coined by Chris Daniels in 1975 and, afterwards, made popular by Bob Heyman while producing documentaries for the National Geographic society [5].

This type of educational tool can be very helpful to understand not only the present but also the past world as in the case of the medieval history of *Yrsum* object of simulation of a serious game, aimed at assessing the potential of remote sensing data in edutainment. *Yrsum* has been selected because it is a case study already investigated [6–9] by means of remote sensing approach as well as it is an emblematic case of abandonment of settlements in Late Middle Ages, which was a very common phenomenon throughout the whole Europe, attracting the interest of several historians and archaeologists [10].

3. Yrsum: history and state of the art of investigations

Yrsum is located in the territory of Irsina, on a hilly plateau, named Monte Irsi, overlooking the confluence of the Bradano and Basentello rivers, close to the border between Basilicata and Apulia regions, in the South of Italy (Fig. 1). Its strategic location favoured

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