GIS AND 3D DIGITAL RECONSTRUCTION FOR THE VALORISATION OF THE ECCLESIASTICAL HERITAGE OF VITERBO

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Abstract

Viterbo is a city of Lazio in central Italy, seriously damaged by the bombings of the Second World War. The air raids of 1943-1944, affected 45% of the historic centre including 21 ecclesiastical structures. This contribution summarizes part of the results produced within a broader project, named EcoDigit (Digital Ecosystem for the fruition and valorisation of Lazio's cultural heritage and activities) of the 'Centro di Eccellenza Distretto Tecnologico Beni e Attività Culturali, DTC Lazio'. The University of Tuscia participates to the project together with the other four universities of Lazio and the research institutes: CNR, ENEA and INFN. The work presented in this paper makes use of Geographic Information Systems (GIS) for the interactive and multimedia mapping of the ecclesiastical heritage of Viterbo and 3D digital reconstructions for the graphic restitution of a specific ecclesiastical structure, i.e. the church of Santa Maria delle Fortezze, largely destroyed by bombing and now in a state of neglect.

Keywords: bombing, Second World War, ecclesiastical, heritage, topography

1. Introduction

The valorisation of cultural heritage, and in particular of the ecclesiastical one, should not be limited only to the material preservation of the building but it must include also the safeguarding of the relationship between the building and its context. Further, it is necessary that the cultural heritage could be usable by the community [1]. For this reason, modern technologies, in particular GIS and 3D reconstructions are considered useful tools because they facilitate the communication and knowledge/understanding of cultural heritage. This is done using the Open Source Geographic Information System QuantumGis® (QGIS) and the following vector drawing and 3D rendering software: AutoCad®, pCon.planner® and Lumion 3D®.

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The aim of this work is to propose an integrated informative model, composed of different digital environments, from the geographical space (GIS and 3D reconstruction models) up to the Virtual Reality. Using the GIS mapping in contexts other than purely geographical ones allows us to build an exhaustive cognitive system aimed at cataloguing, in this specific case, the main ecclesiastical heritage of Viterbo and their architectural history. It must be said that the GIS does not have an exclusively cognitive value, as it allows to propose innovative themes for reading the territory and consequently for suggesting new routes of tourist value. Furthermore, the integration of the GIS map with a 3D reconstruction transforms the cognitive experience into an event and a 'participatory' place in which the access to cultural contents and the construction of information is realized through personal participation. In fact, from the '3D digital scene' derive those methods of approaching cultural heritage based on emotional and sensorial involvement; modalities that mostly materialize through essentially visual communication models, which are based on memory, on narrative, on complicity, thus favouring the involvement of spectators [1]. A phenomenon that becomes more intense if the 3D experience becomes even more immersive thanks to the Virtual Reality that surrounds the viewer in a 360-degree visual reconstruction of the cultural heritage or, as in this case, inside a church before its destruction due to the Second World War bombing.

2. The GIS - operational goals

GIS is an information system capable of associating data with their geographical position on the Earth's surface with the aim at processing and extracting information [2]. For this work it was decided to use the open source software QGIS® (Quantum GIS).

The reference system chosen for the project is WGS84/Pseudo-Mercator because it was decided to use Google Satellite® as the geographical base. Subsequently the CTR (Regional Technical Map) of Viterbo, at the scale 1:5000, was loaded into the project. This basic mapping was used to identify the area of the city and the position of the churches. A new layer was then created that contains four historical geo-referenced photos of the RAF (Royal Air Force). The photos highlight the bombing damage that occurred between February and March 1944, and now are stored at the Aerofototeca Nazionale of Rome (AFN) [3, 4].

On this basis, all churches in the historic centre of Viterbo and the area next to the medieval walls have been mapped with point vectors.

The 21 bombed churches during air raids were mapped separately with star-shaped dot vectors (Figure 1). These geometries have been associated with an 'attribute table' containing the following information for each church: name, position, date of construction, date of the bombing, time of the bombing, if destroyed, if damaged, if reconstructed, further descriptive information and photos. In the 'destroyed' and 'damaged' fields the words 'yes' or 'no' indicate the possible destruction or damage suffered by the church due to the bombing. In the 'reconstruction' field the words 'yes' or 'no' have been inserted, if possible

post-war works were carried out or not and, the date of reconstruction if available. In the 'description' field the damages suffered by the church can be consulted in a PDF file accessible with a click on the point of the church of interest, visible on the map.
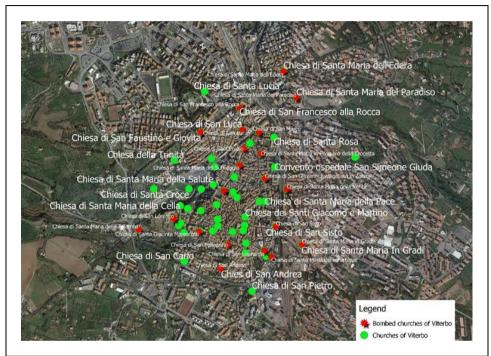

Figure 1. Map of the main churches of Viterbo.

Figure 2. The attribute table containing the information for each church.

The 'photo' field through the 'Open Photo' action allows to view a historical photograph of the church simply by clicking on the vector representing the church (Figure 2).

A layer, called 'Target', identifies with polygons the main targets of the bombings: the two railway stations of Porta Fiorentina and Porta Romana and the airport 'Tommaso Fabbri'. Another layer called 'bomb craters map' identifies, with dot vectors, the craters generated on the ground by bombs and visible from aerial photos. These last two layers allow us to identify the radius of dispersion of the bombs with respect to the position of the military strategic objectives.

3. The 3D digital reconstruction

It was decided to include, in the GIS, the three-dimensional reconstruction of a specific selected church, today partially in ruins, damaged by bombing of 1943-1944. The chosen church is Santa Maria delle Fortezze, built in the 16th century close to the city walls (Figure 3). The church had a large rectangular basilica-shaped hall, divided into three naves of different heights, even if covered by a single pitched roof. The vaults were supported by tall Doric pillars, covered with large slabs of local stone commonly called 'peperino'. The entablature consisted of a frieze, enclosed in a sober frame, bearing a sacred inscription that was to take place along the entire internal perimeter.

What has been described can still be partially detected by the remains of the church, while no evidence of the possible façade appearance is today preserved. The original church project remained partially unfinished; it was modified around 1570, when the main entrance was moved from the east façade, in correspondence of the road that connected Viterbo to Rome. The realization of the new access, in the northern side of the church, is testified by some photos made before the Second World War, that show the façade covered by 'peperino' slabs, while the door was framed by an important portal composed of two semi-columns in Doric order, placed to support an entablature with alternating metopes and triglyphs, and the arched tympanum [5-8].

The first step of the reconstructive work was to find the existing graphic documentation. Subsequently, through close range photogrammetric systems applied to air photos taken by UAV (Unmanned Aerial Vehicle), measurements of the entire remaining part of the structure were obtained [9].

Starting from these data, a CAD Software was used to reconstruct all the architectural parts of the building, divided into layers, on a 1:1 scale. After reconstructing the building as a whole, the model was loaded into the pCon.planner® software in order to separate the surfaces of the polygons that make up the building and identify the groups of polygons to be textured. Finally, the model was included in the lumion 3D® software for the surface rendering phase so as to make them photorealistic (Figure 4). Through this last software it was possible to create 360 degree views of the church in virtual reality, in order to return the architectural complex in its entirety and make the visual experience of the potential visitor more immersive. The goal is to allow anyone to access the 3D

model in virtual reality from a simple smartphone, using specific VR glasses, and to view the church as it was before the bombing.

Figure 3. Santa Maria delle Fortezze church from north side.

Figure 4. 3D reconstruction of Santa Maria delle Fortezze church.

4. Results

The GIS can be considered as a thematic database in which all information regarding the churches of Viterbo destroyed or damaged by the bombings of the Second World War are inserted.

The uploading of cartography and aerial photographs into the GIS allows some observations to be made. Aerial photographs make it possible to detect the urban transformations of the city over time. In addition, these photographs allow us to assess the damage suffered by the medieval historic centre of the city, especially during the Second World War, a historical period that is often not considered in the Archaeological chronology but which has heavily marked the history of the monuments in Viterbo and generally in all geographical areas interested by wars.

GIS makes it possible to create new information layers so as to identify new results that are not clearly visible before or to process spatial and statistical analysis by overlapping multiple layers [10, 11]. It makes also possible to obtain thematic maps by specifying a selected field.

Thank to GIS, it is possible to highlight, for example, that the churches hit by the bombings were located along the main streets of the city. Moreover, the mapping allows identifying the progression of the bombardments on the different areas of the city on the base of the raid dates. Therefore, for the churches whose bombardment date is unknown, it can be assumed that they were hit together with the churches closest to them whose date is known. For example, it is possible that the church of Santa Maria delle Fortezze, destroyed on an unknown date, was struck in May 1944 as the nearby church of San Leonardo whose bombing date is well-known by archive documentation.

The digital reconstruction of the church of Santa Maria delle Fortezze allows us to show how the church turned out before the destruction. The metrically correct and 1:1 scale model allows scholars to make historical-artistic and architectural comparisons with other similar structures in Viterbo and in other cities. In addition it gives the visitor the opportunity to better understand the remains that are still present today. Virtual reality also allows for faster and more popular form of dissemination of the structure and its parts as well as its history.

5. Conclusions

The results presented in this paper offer a contribution to the analysis and interpretation of the dynamic transformation of the historical centre of Viterbo and of its ecclesiastical heritage.

GIS and 3D are useful tools to increase the quality and quantity of information that can always be updated. These tools will be a valuable support for historical research on the churches and the history of Viterbo and in particular for the historical period between 1943 and 1944.

The information gathered about ecclesiastical architecture and its transformations caused by the Second World War will also be useful for possible future restoration work and archaeological studies. In fact, wall structures could have been modified by not documented reconstruction works immediately after the War to restore their function, often using the same construction materials as the original building or church (from the same quarries or reuse materials from the ruins of the edifices). But the objective of this project is not limited to the mapping and cataloguing of churches and war damages: 3D and virtual reality want to offer a different 'access' to the history of the ecclesiastical heritage of Viterbo, contributing to the knowledge of a historical period, not so far in the time, but causing great changes in the city and giving it the present urbanistic aspect.

At present the GIS is a prototype of a new research never developed before that, in the future, will be available online with various knowledge levels suitable for different kinds of visitors: historians and art-historians, archaeologists, architects or tourists.

Acknowledgement

References

[1] E. Ippoliti, A. Meschini, A. Moscati and D. Rossi, *3D Visual Interfaces and Technologies for understanding, sharing and promotion Cultural Heritage*, Disegnare Con, **5(1)** (2012) 45-54.

[2] A. Zaccaria Ruggiu and C. Maratini, *Il Gis dello scavo di Pompei. Nuove ricerche archeologiche nell'area vesuviana (scavi 2003-2006)*, Atti del Convegno Internazionale, L'Erma di Bretschneider, Roma, 2007, 180-188.

[3] O. Paccosi, *Viterbo anno quarto (1944)*, Moderna Stampa Offset, Roma, 1994, 99-289

[4] G. Scardozzi, *Viterbo*, in *Lo sguardo di Icaro. Collezioni dell'Aerofototeca Nazionale per la conoscenza del territorio*, Campisano editore, Roma, 2003, 528-529.

[5] P. Giannini, *Viterbo guida alla scoperta*, Grotte di Castro, Annulli Editori, 2010, 1-216.

[6] L. Gregori, *La cinta muraria, in «Il centro storico di Viterbo»*, Betagamma, Viterbo 2001, 225-228.

[7]   A. Scriattoli, *Viterbo nei suoi monumenti*, FAVL Edizioni Artistiche, Viterbo, 1988, 328-329.

[8] M. Galeotti, *Addio… vecchia Viterbo!*, vol. 2, Stabilimento Agnesotti, Viterbo, 1987, 640.

[9] C. Pelosi, L. Lanteri, G. Agresti and U. Santamaria, Eur. J. Sci. Theol., **12(1)** (2016) 271-281.

[10] M. Mautone and M. Ronza, *Patrimonio culturale e paesaggio. Un approccio di filiera per la progettualità territoriale*, Gangemi, Roma, 2010, 101.

[11] P. Moscati, Archeologia e Calcolatori, **9(1)** (1998) 191-236.