



ANALYSIS OF HISTORICAL EVOLUTION AND PRESENT STATE OF CONSERVATION OF REGIO VII, INSULA 14 IN POMPEII

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Abstract:

The present work is intended to provide preliminary results about the ongoing collaboration in the study of a site located in the Archaeological Park of Pompeii, the *Regio VII, Insula 14*. The research group include experts in archaeology, geomatics and structural engineering disciplines belonging to the University of Genoa. The aim of this cooperative work is twofold: on the one hand, to deepen the designated use that rooms had in the past and their spatial layout, examining the surviving hints about what is no longer visible; on the other hand, to analyse the state-of-the-art in terms of structural behaviour, checking the eventual necessity of urgent retrofitting interventions. In this scenario, there is the necessity of high-quality surveying, geometrically and thematically reliable, in order to allow further studies basing on the 3D representation of the entire "*insula*" and 2D projection of each wall. A description of the site of interest is reported, then information about the survey campaign performed in September 2020 employing Photogrammetry, Terrestrial Laser Scanner (TLS), Total Station (TS) and Global Navigation Satellite System (GNSS) techniques follows. A brief excursus about the survey operations and the ongoing post-processing is shown, with a mention to the expectations about the final results.

Keywords: cultural heritage, documentation, walls' stratigraphy, 3D reconstruction, survey integration and accuracy, 3D virtual analysis

1. Introduction

In the last years, the application of Geomatics techniques to the context of Cultural Heritage is increasingly a consolidated practice. In facts, the acquisition of reliable metrical and thematic information of an object is extremely important in view of its physical and testimonial preservation and study.

The present work, born from the cooperation of archaeologists and engineers, is intended to describe the preliminary results of the ongoing study about the *Regio VII, Insula 14* site in the eminent scenario of the Archaeological Park of Pompeii (Capobianco, 2019; Pallecchi & Santoro, 2019; Pallecchi, 2018). Concerning the applied techniques, an integrated approach has been planned for the survey (Gagliolo et al., 2018a; Gagliolo et al., 2018b; Casella, Chiabrande, Franzini, & Manzano, 2019), in order to exploit all the features of the available instrumentation, consisting in Unmanned Aerial Vehicle (UAV) and terrestrial Photogrammetry, Terrestrial Laser Scanner (TLS), Total Station (TS) and Global Navigation Satellite System (GNSS).

The territory of the Archaeological Park of Pompeii has been recently the scene of several integrated surveys, as

described e.g. in Francolini, Girelli, & Bitelli (2020), Verde (2020), Monego, Menin, Fabris, & Achilli (2019).

In the analysed scenario, the survey of the area is mandatory to support further studies from the archaeological and structural points of view, based on reliable metrical knowledge of the site. Hence, the two aims are: on the one hand, to investigate the destination of use that each space had in the past and the reciprocal relationship among rooms, deepening the surviving hints about what is no longer visible; on the other hand, to analyse the state-of-the-art in terms of structural behaviour, to check the eventual need of retrofitting urgent interventions.

The dissertation is organized as follows: section 2 contains a description of the site; section 3 regards the survey campaign carried out in September 2020, with a brief report of the operational steps and the employed instrumentation; section 4 concerns the ongoing post-processing phase, mentioning its criteria. Conclusions and future perspectives complete the paper.

2. Regio VII, Insula 14: site description

The *Regio VII, Insula 14* is a district of about (60×35) m, located in the western part of Pompeii: it faces south on

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the most important road artery of the city, *Via dell'Abbondanza*, and is bordered westward by *Vico della Maschera*, northward by *Vico dello Scheletro* and eastward by *Vico del Lupanare*. The area of interest is located close to some of the most important monuments of Pompeii, including the Civil Forum, the Stabian Baths, the Triangular Forum and the Theater District, confirming its importance in the urban development framework.

The *insula* is composed by three houses and 12 shops, divided among 20 entrances located on all four sides of the district. In the northern part of the complex, in correspondence with the boundary of houses VII, 14, 9 and 15, a masonry structure made up of large blocks of soft lava is visible (De Simone et al., 2008). Dating back to the 6th century BC, it can be considered a proof of the antiquity of this area of Pompeii within the urban fabric.

The building on which the survey activity has been focused (*Domus* VII, 14, 5) is a large dwelling (656 m²) which occupies almost the entire western sector: it is an *atrium domus*, composed of 27 rooms, whose life stages are connected with those of the adjacent shops.

The activities of the University of Genoa, started in 2016 and still ongoing (Permission DDG 553 34.31.07/246.7 of 26 January 2016 and renewal 34.31.07/3.4.7/2018 of 9 April 2019), have the aim to reconstruct a detailed picture of the history of this district of Pompeii, outlining its evolution over time, its phases of life, its relationship with the rest of the city, the function of the shops facing the street. Parallel to the excavation activity, which led to important results regarding the history and the function of the shops, a stratigraphic analysis of the walls was carried out, involving all the structures of the district. The aim of this activity is to outline the construction events of the *insula* and its changes from a structural point of view, proposing a reconstruction of its appearance in some phases: traces of secondary elements (stairs, regular rows of holes in the walls, drain pipes) may suggest the presence of one or more upper floors. The survey and the structural analysis activities could confirm the hypotheses proposed by the stratigraphic analysis.

In particular, the activities of archaeological investigation and wall analysis have been concentrated in recent years in the western portion of the *insula*, which includes the *Domus* VII, 14, 5 and the shops 1-4, 6-7, managing to reconstruct the evolution and the succession of phases ranging from the late Samnite period (III-II century BC) to the eruption of 79 AD.

3. Survey campaign

A survey campaign has been performed in the period 22nd-24th September 2020, using UAV and terrestrial Photogrammetry, TLS, TS and GNSS techniques. A preliminary inspection has been achieved onsite on 18th July 2020, in order to define the aims with the reunited research team, consisting in three groups expert in archaeology, geomatics and structural engineering.

Concerning the employed instrumentation, the UAV photogrammetric survey has been achieved by means of the drone DJI Mavic 2 PRO, with an embedded Hasselblad L1D-20c camera. The focal length is 10 mm, while the 20 MP sensor is a CMOS with a size of 1". Four datasets have been acquired, including two nadiral (Fig. 1) from different flight heights Above Ground Level (AGL),

40 m and 15 m respectively, and two tilted (45°) taken from two concentric paths looking towards the internal and the external of the perimeter at 15 m AGL. The resulting Ground Sample Distance (GSD) at 15 m is about 4 mm, sufficiently precise to obtain a reliable overview of the whole site; instead, the GSD at 40 m is about 10 mm, allowing a general framework of the area. The total amount of frames is about 1400.



Figure 1: Aerial view of the *Domus* 5 and close workshops.

The Ground Control Points (GCPs) and Check Points (CPs), 21 in total, have been identified by means of flexible PVC supports coloured with a cross-pattern of alternated black and yellow triangles. Their coordinates have been acquired by means of the TS Leica TCR703, located on 13 station points.

The TLS has been employed in order to acquire more in details the specific areas of interest, in particular the rooms of *Domus* 5. A total amount of 26 scans have been performed in the likewise spaces of the building by means of the Z+F 5006h scanner, setting super high resolution corresponding to 20000 points on 360°. Considering an approximate distance from the walls up to 5 meters, the resulting spacing between points is maximum 1.6 mm. Each scan is focused on a single room, typically closed on three sides. In order to avoid the excessive increase of the number of scans needed, the reciprocal overlapping of points for the registering operation has been disregarded, favouring the alignment with the survey coming from UAV Photogrammetry. The GNSS Network Real Time Kinematic (NRTK) survey, in connection with the Regional positioning Service of Campania, has been applied also to the GCPs if no obstructions were in the line of sight of satellites direction.

The use of a couple of clearly identifiable points for each scan, represented by nails and acquired by means of GNSS, has been adopted for the registration in a global Reference Frame (RF), obtaining an approximate reciprocal positioning and orientation of the scans themselves.

The terrestrial photogrammetric survey, acquired by means of the Canon Eos 40D camera with a focal length of 17 mm, has been planned in order to maintain a maximum distance from the walls of 5 meters, obtaining a GSD of 1.7 mm. Nevertheless, for a further enhancement of the level of detail, the distance onsite has been maintained around 2 meters, corresponding to a GSD of 0.7 mm. About 7000 images have been collected.

4. Ongoing post-processing operations

The ongoing post-processing operations are based on the same abovementioned criterion used to collect data: a different level of detail is distinguished for the whole *Insula* or for the specific parts of interest in *Domus 5*.

Concerning the photogrammetric post-processing, the software packages that will be employed are Agisoft Metashape© and MicMac: the former will be used for the reconstruction of the 3D model of the entire *Insula* by means of the aerial images, while the latter will be used to treat data from terrestrial photogrammetry. The aim is to use the latter dataset in order to produce high-reliable orthophotos with an adequate resolution to perform both archaeological studies and structural analysis.

The TS and the GNSS dataset will be used to attribute a local or global RS, respectively, to 3D and 2D products. Finally, the TLS scans will be reciprocally registered, to have a unique high-resolution model of the *Domus 5*.

5. Conclusions and future perspectives

The present work concerns the preliminary results of synergic cooperation among three research groups of the University of Genoa, experts in archaeology, geomatics and structural engineering, in the analysis of the *Regio VII, Insula 14* site within the Archaeological Park of Pompeii. The aim is twofold: starting from a reliable 3D reconstruction of the area, archaeological and structural analysis will be performed to investigate the past and the

present condition of the site. The interest is focused on the one hand on the past destination of use of the rooms and their spatial layout, inferable from what still present nowadays, on the other hand on the state-of-the-art in terms of structural behaviour, to recognize eventual risks.

The eminent context is absolutely stimulating and worthy, as well as the cooperative work, which allows to further appreciate the value of the different skills.

The future perspectives consist in: first, the conclusion of the post-processing operations related to the survey, then the achievement of archaeological and structural analyses to both recognize the historical evolution of the site and the present state of conservation.

Acknowledgements

The authors wish to thank:

- the directorate of the Parco Archeologico di Pompei, for the release of the authorisations and the support;
- Prof. Stefano Podestà and his collaborators of Yellow Room Engineering for the contribution they will offer in the structural analysis;
- Ce.Dro., University of Genoa, for the realization of the UAV photogrammetric survey;
- Scuola Droni Genova and Eurodrone Flight Systems for the cooperation.

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