The Mosaics of Lin Basilica, Albania. Photogrammetry and Musealization.

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In Albania, as time passes, a larger part of the archeological heritage is discovered, but for many places there is still the need of a deeper exploration and a better musealization. This project studies a single link from the chain of monuments distributed through Via Egnatia, the antique pathway that connected Western with Eastern Roman Empire; beginning from Dyrrahu (Durrës, Albania) and ending in Constantinople (Istanbul, Turkey). The focus of this research is on the medieval basilica of Lin which is located on top of a rocky appendix over the lake Ohër on the albanian shore. The basilica features a composition of multilayer constructions from different historical periods and reaching the climax in the VI century under the Byzantine Empire. Because of its entire pavement covered in mosaics and its rare chapel typology, the basilica deserved further examination. Today the site lacks a protection from the weather and a structure that could make possible the access to the mosaics. The research initially consisted on the survey of the area by including the hill where the site is located because if its unique landscape on the lakeshore. The gathered data subsist in more than 500 high quality photos captured manually, numerous more were added with GPS data and video shots taken from an UAV where most where taken in 360°. From this photogrammetric survey, a virtual 3D model has been created. These data provide a meaningful document for the preservation of the heritage and a base for further steps of the research. The project also encompasses the design of a pavilion that operates as a protective structure and allows the musealization of the site by including recreational cultural activities to broaden its fruition.

Key words:
Albania, byzantine basilica, mosaics, photogrammetry, musealization.

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INTRODUCTION

The archeological survey with both historical and geographical documentation is the essential component of this study in order to fulfill the intended preservation and musealization proposal for the remains of the Lin Basilica and its mosaics which embodies one of the best preserved examples in churches from the VI century in Albania.

Despite the importance regarding the archeological overview, today the site is exposed to the atmospheric agents since the mosaics are protected only with PVC sheets covered by a 10 cm layer of sand.

This kind of protection does not offer a long-term preservation and impedes the exhibition of the mosaics to the public, thus draining the area from an important cultural resource.

A thorough study of the area has been carried on in order to gather enough data to reevaluate a protection for the archeologic remains. A light metallic structure has been designed to serve as an exhibits pavilion to highlight the importance of the site and its history.

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The following study describes the steps and the processes of this research where the use of the photogrammetric technique allowed not only the data acquisition, but also a better understanding of the history and function of the archeological area.

The site is listed as a first category monument, thus a non-invasive procedure has been chosen to gather all the data.

In this way, after processing the data acquired with the survey, a 3D model of the archeological site was obtained. This output was carried into 3D software in order to develop the design of a pavilion by working directly on the virtual model of the site after the acquisition of the rigorous measurements.

In addition to the design of the structure, a sun simulation was carried on through computer elaborations in order to study the best protection of the underlying mosaics from sunlight and other weather influences.

CASE STUDY: GENERAL OVERVIEW

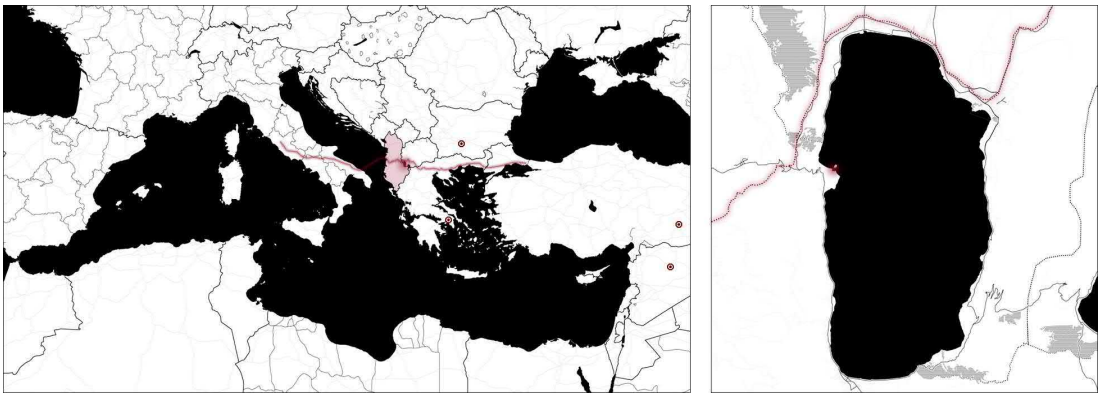
a *b*

Fig. 1. Views from Lin: (a) north side facing the lake, (b) the basilica located on top of the hill.

Lin is a village situated on the peninsula of the Ohër Lake, on the Albanian side and close to the frontier with the F.Y.R. of Macedonia (Fig. 1). Ohër is a natural barrier lake with tectonic origin and it is a water basin which contains the highest diversity of flora and fauna in Europe. Most of these animals and plants have been used as a subject for the decorations in the area and we can find many examples also in the mosaics of the Lin Basilica.

It is possible that the Lin area has been inhabited since the Iron Age as in the South-East zone has been discovered an underwater structure made of wooden poles, dated around the X century BC, probably a base of pile dwellings. This kind of structure is typical of the Neolithic Era [Çikopano 2013].

What appears from studies is that all the area was very populated until the VIIth century, but is only in the middle of VIth century that the Lin Basilica became the main episcopal center in the west coast of Ohër lake (Fig. 2b) by reaching this way its peak of splendor.



a *b*

Fig. 2. The Mediterranean Sea with the antique pathway of Via Egnatia (a) and the lake Ohër with the Lin basilica (b).

The construction of Lin Basilica is tightly connected with the influence of the Roman Empire. During the IIIrd century BC, the Romans started the occupation of territories that belonged to the Illyrian Empire, causing the development of three different wars from the IIIrd to the Ist century BC [Jacques 2009].

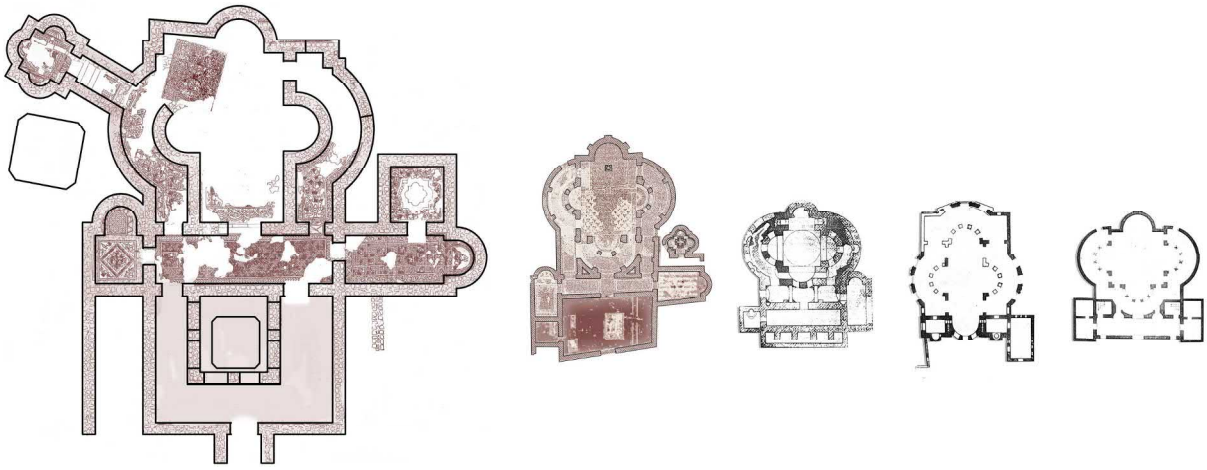
In 95 AC we witness the division into Eastern Byzantine and Western Roman Empire and the Illyrian territories fell under the control of the Byzantine Empire. This area was crucial for communication between Rome and Constantinople not just because of its strategic position, but also for the presence of many harbors and a good road network [Jacques 2009].

The main link between the two Empires was Via Egnatia, built by the Romans in the IInd century BC to connect Dyrrachium (now Durrës) with Byzantium (later Constantinople, now Istanbul) (Fig. 2a) [Basso 2007].

This pathway covered 860 kilometers with stop points every 60 kilometers and crossing through the current states of Albania, Macedonia, Greece and Turkey.

Along the entire Via Egnatia several villages and cities were raised and one of the many buildings of worship erected near this pathway was the Lin Basilica.

The church presents a centralized-plan structure with four apses. We find a cistern in the atrium, the baptistery facing south and on the opposite side a chapel. This plan typology has been used also in the tetraconch of Ohër and we can find other four principal examples that present relevant similarities; the tetraconch of the Hadrian's Library (Athens), tetraconch of Resafa (Sergiopuli, Syria), the so called "Red Basilica" of Perustika (Bulgaria) and the tetraconch of Diyarbakir in Turkey. All these monuments belong to the VIth century (Fig. 3) [Çikopano 2013].



a *b* *c* *d* *e*

Fig. 3. Basilicas of the VIth century with typology similarities; (a) Lin, (b) Ohër, (c) Resafah, (d) Perustika, (e) Panaghia (Hadrian's Library).

The Lin Basilica was the episcopal venue for the bishops of Lyhnid (Ohër) until the tetraconch of Ohër was built on the opposite side of the lake shore.

After the VIth century we have a period of decline in the territory because of the attacks and conquest by several Slavic populations as documented from the VIIth century [Zickel et al. 1994].

Archeological excavations had revealed the existence of an earlier construction that dated around the IIIrd century. During the following three centuries this smaller church developed into a Basilica and reaching its final asset in the VIth century by gaining the shape of what we see today (Fig. 4a) [Çikopano 2013].

a *b* *c* *d*

Fig. 4. (a) Hypothetical model of Lin basilica. Credit: [Çikopano 2013], (b) The Pastoforia, (c) Tiles, (d) Depiction of a bird. Credit: I.M.K.

The entire pavement was covered with mosaics and even though only some areas have maintained the original decoration, it still remains one of the finest and largest example of mosaics in Albania (Fig. 4b) [Anamali 1974].

These decorations, which represent the flora and fauna of the lake and combined with geometric themes, were created using polychromatic stones and glass tiles (Fig. 4c).

Typical of the artisans from Ohër, which influenced the production of all the area, was the use of squared frames with the representation of an animal inside by preferring fishes and birds (Fig. 4d).

Another peculiar characteristic of the mosaics is the reuse of existing decorations; the old tiles were not removed and the prior motif was combined with the new one [Përzhita et al. 2014].

Nowadays the basilica of Lin is set in a rural context, but it is well connected to other cities thanks to the proximity of the trunk road and the railway that could make easier the development of this archeological site (Fig. 5).

Fig. 5. The location of Lin and the remains of the basilica. The main infrastructure is highlighted including the valley that has emerged with the withdrawn of the lake Ohër.

THE PHOTOGRAMMETRIC METHOD

Phases of the survey

Because of the large amount of data that had to be collected, the work was divided in two separate survey campaigns carried out with different instruments. The entire process was planned to ease the post-production hence all the images and metric surveys would later be elaborated using *Agisoft Photoscan.* Different scenes

were captured singularly in order to permit the software a better elaboration and also to avoid errors while processing [Corsi et al. 2013].

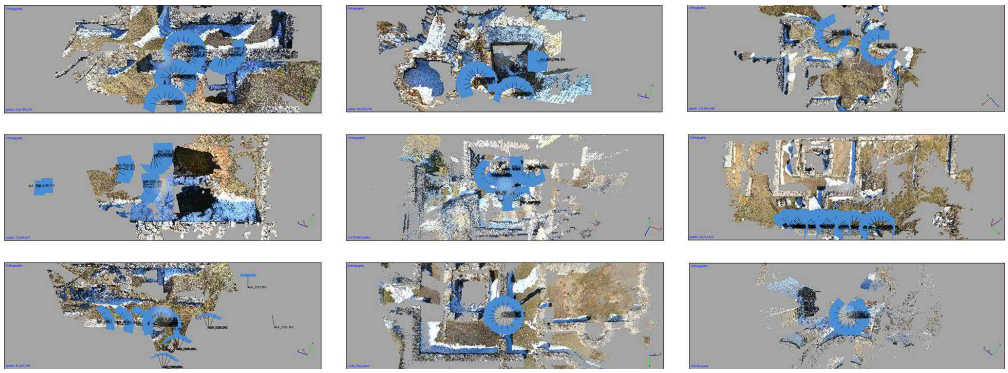


Fig. 6. Various scenes of the site on which panoramic and 360° shots were taken manually. Credit: Arget Toçila.

The first part of the survey took place in January 2017: the campaign gathered the data on the entire archeological site that was then stored into a photo image database. Almost every single photo had a size of over 20 megabytes, and they were gained by using a Nikon D800 E camera. The result of merging large sized photos made necessary the separation into several scenes and for each scene several pictures were shot in 360° in order to prevent software errors and shut downs. The result of the first survey was a large database consisting of over 500 photos which were then integrated with several metric surveys collected simultaneously (Fig. 6).

a *b* *c*

Fig. 7. Survey conducted by an UAV; (a) orthographic shots, (b) 360° shots, (c) peninsula. Credit: Arget Toçila.

The second phase consisted in a photogrammetric survey of the rocky appendix where the archeological remains where located (Fig. 7). Considering the large scale of the area, an UAV (DJI Inspire 1 v2.0) was used to capture the images. In addition to the studied site, the adjacent village of Lin was included in the large-scale survey in order to analyze heights, proportions and also to achieve detailed environmental sections (Fig. 12). The information acquired was later compared with all the data of previous excavations, measurements and interventions on the site, gained by the courtesy of the “Institute of Cultural Monuments”, Ministry of Culture, Albania.

Data processing

All the data gained through surveys were processed with the photogrammetric technique using *Agisoft Photoscan.* The process was completed in different steps that led to the creation of a 3D model. Firstly, groups of images were created, according to the area that they were representing, and they were loaded into the software separately. Then an automatic procedure defined the best method to process each group.

The following procedure was the matching and the so called *"Align photos"* which aligned consecutive pictures thanks to the recognition of common points. This process was in a large scale carried on automatically and the manual alignment was chosen only if the resolution of the images did not allow the automatic option.

Then the software elaborated this information by combining photos together in order to obtain a three-dimensional referred group of images.

The alignment process was followed by the creation of the *"Dense cloud"* for which was chosen the "High" computing option.

Because of the large amount of data, a decision was made to work on separate groups by achieving lighter files in order to allow a more fluid workflow.

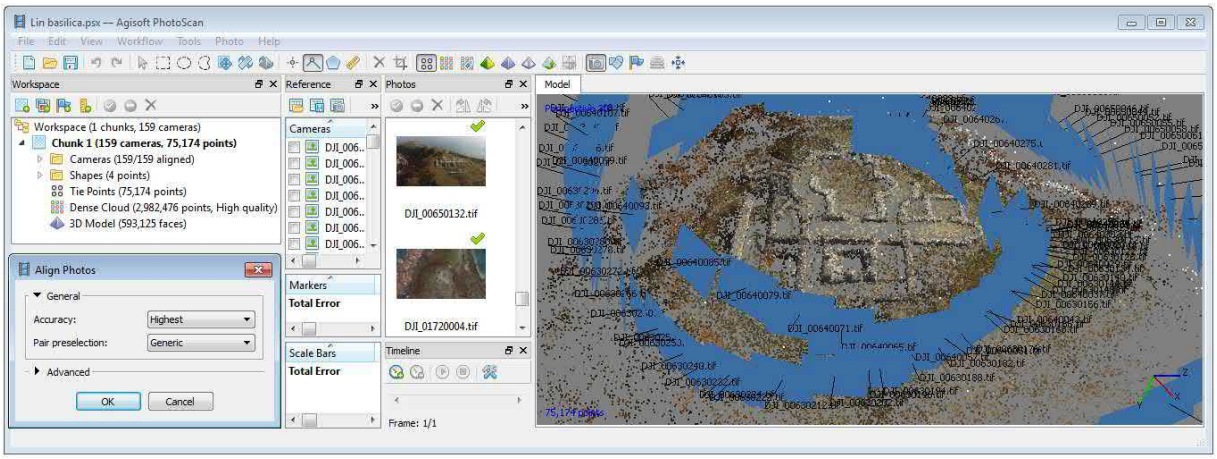


Fig. 8. The process "align photos" where a sparse point model is built from the imported images. Credit: Arget Toçila.

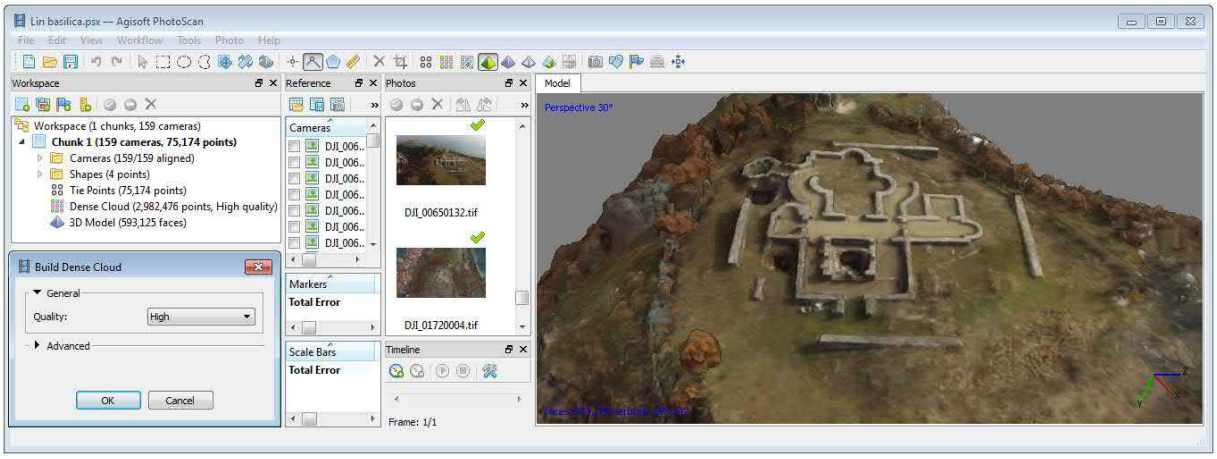


Fig. 9. In the "built dense cloud" the software calculates the depth information of each camera and creates a single dense point cloud model. Credit: Arget Toçila.

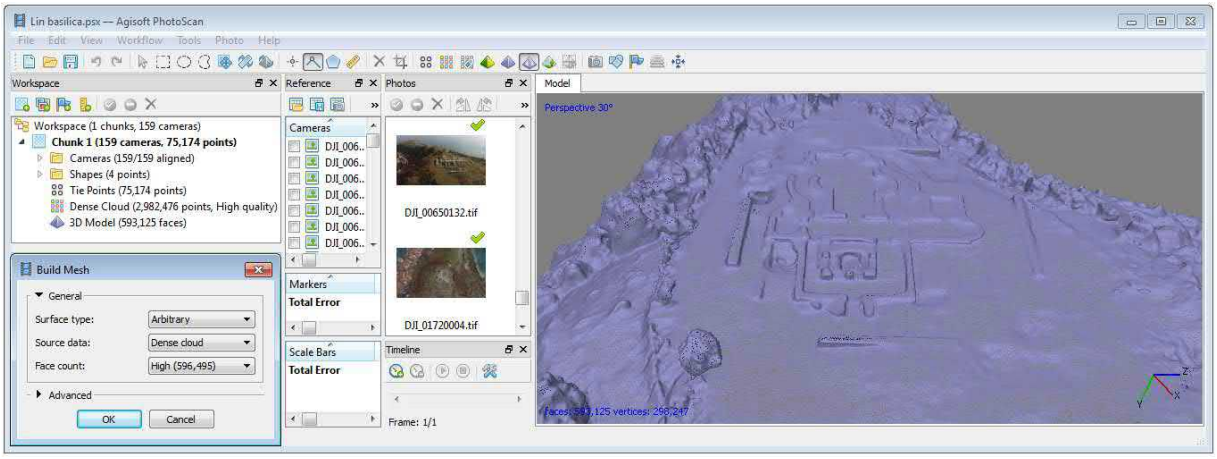


Fig. 10. The mesh reconstruction obtained by selecting parameters in high levels. Credit: Arget Toçila.

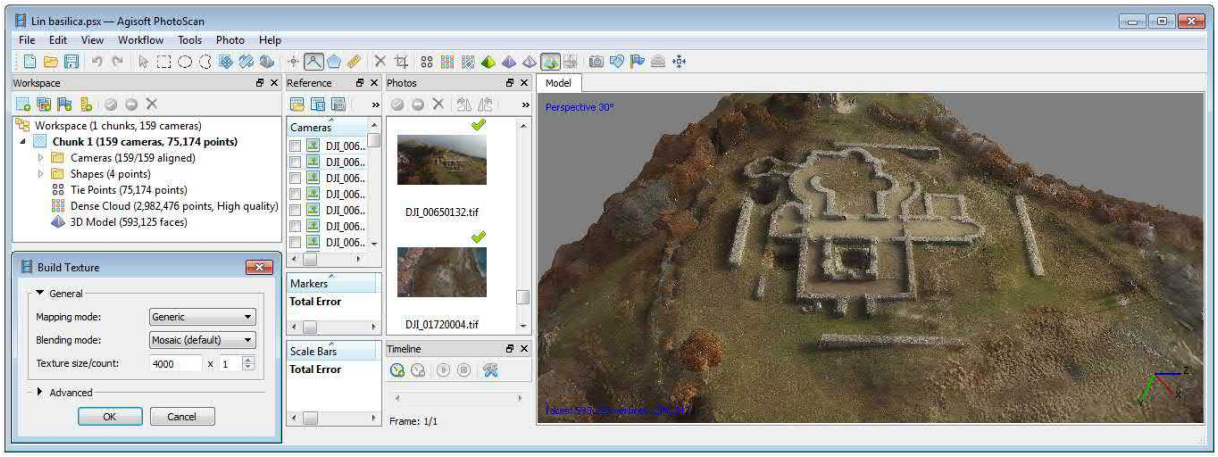


Fig. 11. Generating the 3D texture. Credit: Arget Toçila.

The final steps in the process were the creation of the *"Mesh"* and *"Texture"*, both through automatic procedures.

In this way, we acquired a 3D colored model that could be exported to other modeling software such as *Mcneel Rhinoceros* which was later used during the study.

Fig. 12. Sections obtained from the 3D model with its texture, which was inserted on the surrounding views through Adobe Photoshop. Credit: Arget Toçila.

MUSEALIZATION PROPOSAL

Intervention on the archeological site

The mosaics and the remains of the early Christian basilica are located in a protected area where new constructions are forbidden, unless they have a preservation function. The proposal for the musealization of the basilica aims at its protection and valorization. The envisaged settlement for the foundation is designed entirely outside the perimeter of the walls by following the guidelines of the 1964 International Charter of Venice for the Conservation and Restoration of Monuments and Sites.

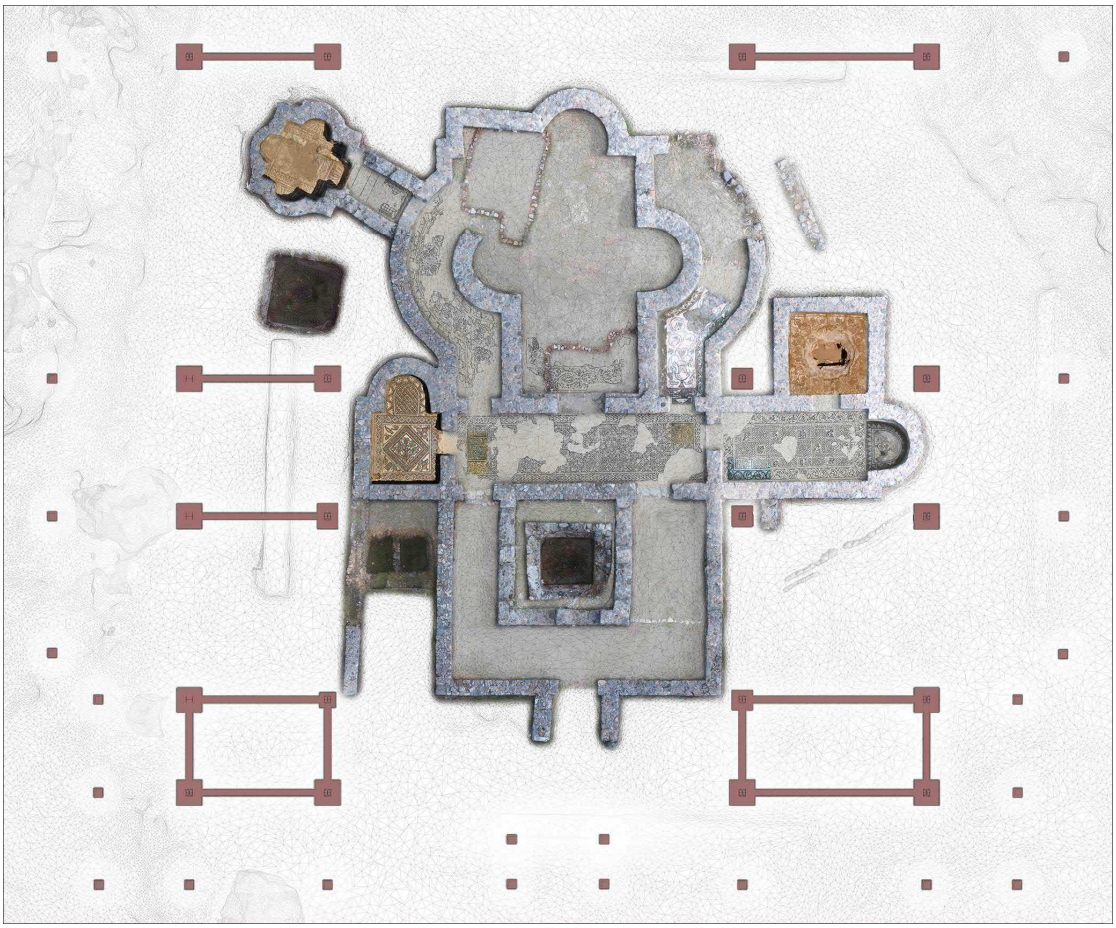


Fig. 13. Orthographic aerial view of the archeological site gained from Agisoft Photoscan. Inside the perimeter walls are exposed parts of the mosaics and outside them the foundation plinths are detached from the existing structure. The central plinths are those that distance the most and have a range of 18m. Credit: Arget Toçila.

The proposal is intended to encompass spaces in order to make visitors perceive the sensations of walking through the same area where once stood the basilica in its full form. The new settlement is detached by 2 meters above the ground: this distance serves to highlight the remains, but also to allow the insertion of the main structure.

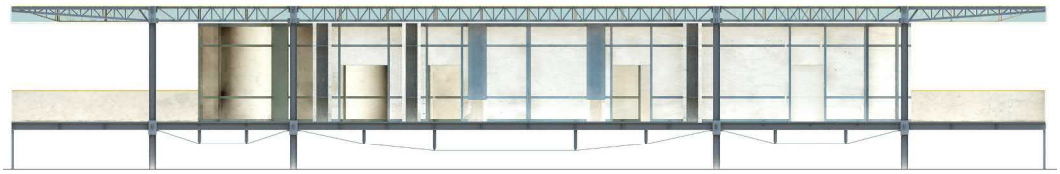


Fig. 14. The section of the front view from where the structure can be seen. Credit: Arget Toçila.

This solution uses steel cables located beneath the main steel beams in order to create a reverse truss layout for a better distribution of the forces applied. The suspended cables are lowered up to 110cm below the beams.

The load-bearing structure is entirely made of stainless steel of HEB and IPE beams with bolted joints. This construction typology allows a light structure and applies sustained loads above the ground.

As well as on the structure, the stainless steel elements are distributed also beneath the floor that is divided in a chessboard grid pattern where the panels inserted are alternately in wood, metallic grid and structural glass.

The external walls of the new structure are framed in steel enclosing the translucent polycarbonate panels as infills. The roof is composed by the truss beams system which is incorporated with panels from both sides.

The architectural proposal and visualization

The settlement proposal submits a square plan of 44 meters by side and a height of 7 meters (Fig. 15). The entrance is composed by the central stairs and lateral ramps. Both are made of stainless steel with wood panels placed as walk-over flooring. The pavement is divided in squares of 2 meters in which are inserted stainless steel frameworks that lay on the secondary beams. The main stairs are 4 meters wide while the ramps are 2 meters wide which reside in a slope of 7% (Fig. 16). The external walls of the new structure rise 4 meters high to the wood ceiling.

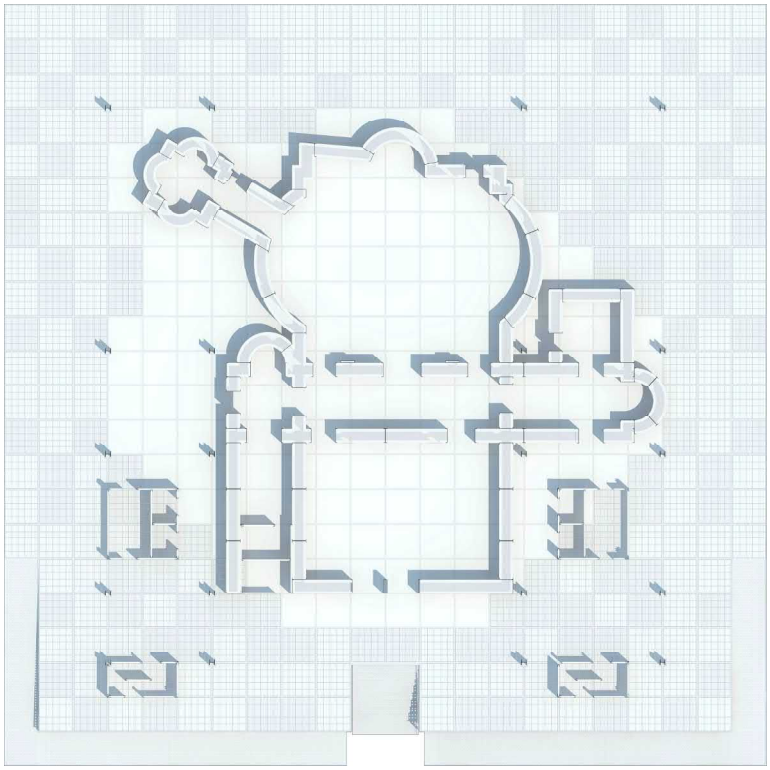


Fig. 15. The floor plan of the architectonic proposal. Inside the perimeter walls, a structural glass pavement covers the mosaics underneath. Credit: Arget Toçila.

The main area of the proposed structure consists on the external walls that follow the ones of the underlying site. This space has an expository purpose designed for the mosaics but could also be used for various exhibitions related to the site.

In front of the main volume are four other spaces located on the west side (Fig. 15). They are designed with a lower height and they house different functions as an information point, historical and landscape guides and a comfortable area to enjoy the panoramic view, towards Ohër.

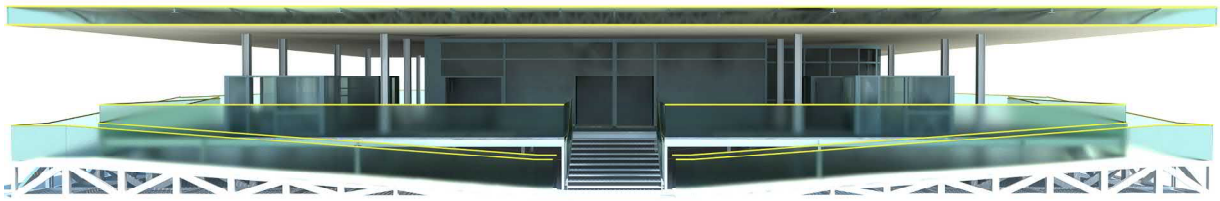


Fig. 16. The front view of the proposal that was designed with resistant, light and translucent materials. Credit: Arget Toçila.

CONCLUSIONS

This study took place as an answer to the emergency the archaeological site is dealing with. The aim of the project is the protection of the area and its valorization for a better enjoyment of this almost abandoned site.

The first step to reach this purpose was a thorough analysis of the place both with historical and geographical documentation along with an updated survey of the site and its surroundings.

The chosen technology allowed a fast acquisition of 3D data and was the perfect solution because of its non-invasive procedure, for a site listed as a first category monument.

A detailed survey, carried on both in small and large scale, gave as a result a large amount of data and all processed through *Agisoft Photoscan*. The output was a colored 3D model of the site and its surroundings, thanks to the use of images captured by a UAV and pictures manually shot, that enriched the level of detail for the model.

All this material was used for further studies on the peculiar plan setting of the basilica and later as a base material for the design of a pavilion that aims to protect the site and allows the exhibition of the mosaics, now covered.

The intention was to maintain a light structure in order to direct the attention not to the building itself, but also to what it preserves. The type of structure, the material, the detachment from the ground and the distribution of spaces were all confined and related with the underlying archeologic site and chosen in the respect of it.

The preservation of the archeological site implies not only the obligation to maintain in life a monument for its historic importance, but also to be able to conserve it for the generations to come as an artifact.

The structure is meant to achieve the functions of a cultural assembly where activities can be carried out by local habitants, institutions and other cultural organizations. Considering the landscape of the region that surrounds the lake Ohër, it is encouraging to endow the augmentation of Lin basilica in order to become a landmark.

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