



Documentation and 3D Digital Modelling: The Case of a Byzantine Christian Temple and an Ottoman Muslim Mosque in Ioannina City, Greece

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Abstract. The specific paper forms part of the Postdoctoral Research Project (Implemented by Athina Chroni, Dr. Archaeologist, supervised by Professor Andreas Georgopoulos, Laboratory of Photogrammetry-National Technical University of Athens.) focusing on Ioannina city's Ottoman period (1430–1913) and its multicultural profile as depicted in buildings, public or private, religious or secular, conventional or more elaborate, each having its own historical and architectural interest.

Unfortunately, most of the landmark buildings have been destroyed due to natural disasters, religious hatred and the unbridled, often uncontrolled modern constructions. However, the existence and form of several of those edifices survived thanks to fragmentary information of various kinds, while their location in the urban web and their dimensions can be clarified, in several cases, by their comparative studies with buildings recorded at the same representations whose location and dimensions are known or buildings preserved until today.

Under this perspective, a variety of data like historiographic, bibliographic, archaeological, cartographic, topographic, remote sensing imagery, optical displays, travelers' descriptions, other literary sources, local legends, inhabitants' interviews have been collected, analyzed, cross-examined and digitally processed, thus leading to the development of a Geographic Information System, the 3D landmarks digital models, a web data base and QR tags at the specific sites, where the landmark buildings used to stand, thus connecting the intangible (digital) with the tangible (physical space) and achieving interaction of the project with the local community. Moreover, cultural walks within the city's urban web, related to the project's axis are also proposed.

Keywords: Cultural heritage · Tangible · Intangible · Documentation · Digitization · Photogrammetry · 3-D modelling · G.I.S. · Open sources · Ioannina

1 Introduction

In 1611, a failed Christian uprising¹ would lead to the abolition of the privileges the Ioannites² had secured with the *Decree by Sinan Pasha* in 1430, when surrendering to the Ottomans. After that year, 35 Christian churches and monasteries were destroyed, of which 18 were located inside the Castle of Ioannina. Any attempt to identify the sites of the Castle's extinct temples, other than the *Cathedral of Taxiarchis Archangel Michael* and the adjacent *Church of Pantocrator*, in the *Inner Acropolis (Its Kale)* of the Castle, would be in vain, as no relevant tradition has been passed over from generation to generation [9].

From 1430 to 1913, 17 mosques were built inside and outside the Castle, two metzites inside the Castle [1, 6, 15] and three *tekes*, each one at each entrance of the city [6]. "Christian churches and monasteries existed in most of the metzitia standing" [1]. In the years 1920s–1950s, 14 of the 19 mosques in the city of Ioannina have been destroyed [10].

The Jewish synagogue inside the Castle had already been built since the 9th century [1, 9], while in 1540 a second synagogue had been founded outside the Castle [13]. The last one has been destroyed in the years 1960s.

2 Selection of Landmarks: Reasoning

The 3D digital approach for specific landmarks of the city, has been one of the scientific fields of the afore-mentioned Postdoctoral Research Project. The landmarks, coming from all the three cultures of the city, Christian, Jewish and Muslim, often stratigraphically and chronologically succeeding one another, create an interesting **cultural palimpsest** reflecting the fluidity of human reality.

In the framework of the specific paper, the following landmarks have been selected to be presented:

- *Taxiarchis Archangel Michael* Christian church, the first Cathedral of the Byzantine period, dated in the 13th century, a landmark completely destroyed in 1795, as estimated.
- *Fethiye* Muslim mosque, having three construction phases as following:
 - 1st phase: 17th c. to 1770.
 - 2nd phase: 1770 to 1795.
 - 3rd phase: 1795 until today, i.e., the building still standing.

Both afore-mentioned landmarks are situated at the *Inner Acropolis (Its Kale)* of the southeastern corner of the Castle of Ioannina.

In both cases it is observed:

- Uninterrupted identical use of the same site as a religious one, until the end of the Ottoman period of Ioannina.
- Successive construction of religious buildings of different religions.

¹ Organised by Dionisius, Metropolitan of Larissa-Trikki. [12].

² *Ioannites* are called the inhabitants of Ioannina city.

3 Methodology

Concerning the specific afore-mentioned landmarks, only the building of Fethiye mosque, dated after 1795, is preserved in its entirety, except for the porch. The Fethiye building preceding the year 1795, has been absorbed by the latter. The Byzantine Cathedral has been completely destroyed.

Taking into account that the typological development of the plan view of the surviving mosques of Ioannina, as well as of those whose composition has been detected with certainty, always follows the same type, it is almost certain that the pre-1795 Fethiye might have the same form as the existing one, probably having differences only in size.

Detecting the form of the Byzantine Cathedral has been the great challenge of the specific part of this research, given the absence of extensive archaeological findings to substantiate and figure out the type of the Christian Cathedral, as well as its exact location at the southeastern acropolis of the Castle, in relation to Fethiye mosque's successive construction phases.

Consequently, the research has been based on the following documentation data:

- Historical data on the city of Ioannina.
- Bibliographic reports-testimonies- fragmentary archaeological findings.
- Typological data on Byzantine Christian churches' and monasteries' as well as on Muslim mosques' architecture.

4 Taxiarchis Archangel Michael Christian Cathedral and Fethiye Muslim Mosque: Location and Dating

The intensive, cross-examined study of the related bibliographic references, archaeological findings and testimonies lead to the safe conclusion that:

- The existence, at the southeastern citadel of the Castle, of a temple dedicated to Taxiarchis Archangel Michael, a Christian church which was at the same time the Cathedral of the Late Byzantine period of Ioannina, cannot be disputed.
- Nor can be disputed the fact that an earlier Fethiye mosque building, with two successive construction phases should have existed before 1795.

4.1 Location

The location of the Cathedral of Taxiarchis Archangel Michael can be assumed in combination with the study of the location of the pre-1795 Fethiye mosque, in its two successive construction phases,³ as well as with the consideration of the location of the after-1795 Fethiye Mosque, existing nowadays.

³ 1st phase: 17th c.-1770. 2nd phase: 1770–1795.

It is likely that the existing Fethiye mosque is spatially identified, with small differences, with the pre-1795 existing mosque,⁴ after the implementation of Ali Pasha's building program, in the framework of which the mosque had, probably, been resized.⁵

However, it is not clear whether Fethiye mosque is completely spatially identified with the pre-existing Christian church of Taxiarchis Archangel Michael, the city's first Cathedral. Most likely, the mosque was originally built very close to it, since until 1770 the walls of the Christian church were visible, the frescoes as well. Exactly in that year the Christian temple was completely destroyed, on the occasion of the reconstruction of Fethiye mosque, until then adjacent to the church: it is when the area of the temple was integrated in the Muslim mosque.⁶

In this light, it results that the Cathedral of Taxiarchis Archangel Michael, concerning its location, is probably not entirely identical with the location of the existing, nowadays, Fethiye Mosque: it should have been located approximately where the Fethiye Mosque is today or, rather, a little further, to the center of the plateau of the southeastern citadel [8]. We should also always take into consideration that the pre-1795 mosque, as finally formed after the interventions of 1770, might be not entirely identical with the after-1795 mosque, regarding the size and the location.

4.2 Dating

Taking into consideration the historical data it becomes clear that the date of construction (or reconstruction) of the Cathedral of Taxiarchis Archangel Michael should be determined at the time of the re-inhabitation of the city of Ioannina, i.e., shortly after 1204 [8, 16].

⁴ The mosque having taken its final form after 1770.

⁵ If we accept the dimensions referred by Celebi, for Fethiye mosque then it turns out that the current building of Fethiye, as it was formed after the construction works of Ali Pasha, is larger than the pre-1795 Fethiye, and not limited according to Vranoussis [16]. This is a conclusion quite strong, since it would not be reasonable for Ali Pasha to reduce the size of the top-mosque of Ioannina, his city-headquarters, but rather to render the specific mosque bigger.

⁶ The mosque having three construction phases:

- 17th century to 1770: The mosque is adjacent to the church. The church is still existing, although as ruins.
- 1770 to 1795: The mosque is adjacent to the church. The church is destroyed in 1770. The mosque undergoes major renovation and "absorbs" the ruined church.
- 1795 until today: Reconstruction of the mosque with radical alterations concerning the location and the size of the building.

5 Taxiarchis Archangel Michael Christian Cathedral: Form and Characteristics

5.1 Form

Taking into account the data on Byzantine temple typology concerning the Middle⁷ and Late⁸ Byzantine period, we consider highly probable that the Christian temple of Taxiarchis Archangel Michael, must have followed the type of the *basilica*, rather *three-aisled* and, perhaps, *vaulted*, given that the *dome basilica* has already appeared since the Early Byzantine period: as a result, we find multiple examples of temples following the type of the *vaulted basilica with a dome* in the Middle Byzantine period.

It is worth mentioning that, according to Xyggopoulos [17] most of the Cathedrals of the 11th and 12th c., and even later, follow the *basilica* type, probably in order to keep the tradition and pay respect. Additionally, this type of building is very spacious and suitable for gathering a large number of people [16].

Moreover, in 1670 the Ottoman traveler Evliya Celebi, referring to Fethiye mosque, describes it as an “ancient mosque with a saddle-type roof” [7, 15]. Perhaps Fethiye mosque had already incorporated a large part of the, rather adjacent, temple of Taxiarchis Archangel Michael: we could, therefore, conclude that the “saddle-type roof” belongs to the Christian Cathedral of Taxiarchis, which, therefore, would have been rather *vaulted* and, perhaps, *domed*.

Considering the afore-mentioned, the Christian church of *Hagia Sophia in Ohrid*,⁹ (Fig. 1) dated in the end of the 9th c. until the middle of the 11th c.¹⁰ [5], which was also founded as a Cathedral [11] and belongs to the type of the “*vaulted basilica with a dome*”, [11]¹¹, has been considered to be the right choice as a model for the probabilistic

⁷ 867–1204 AD.

⁸ 1204–1453 AD.

⁹ The years after 901–907, the Diocese of Ioannina will continue to belong to the Metropolitan of Nafpaktos, except for a short period of time that it came under the Archdiocese of Ohrid, immediately after its establishment. [8]: the connection between Ioannina and Ohrid is already confirmed by a *sigil* of the Emperor Vasileios B', dating in the year 1020, related to the Archdiocese of Ohrid, according to which is determined the extent of the ecclesiastical power of the Archdiocese of Ohrid, after the overthrow of the Bulgarian state. For the years before 1319, the Bishops of Ioannina are not mentioned by name, except for Zacharias (879) who is considered as controversial. Concerning Ioannina, for the year 1020, a Bishop under the Archbishop of Bulgaria, named Ioannis is mentioned, while for the year 1232 an anonymous Bishop under the Metropolitan of Nafpaktos is mentioned. [19].

¹⁰ According to Gioles it is considered more probable today the founding of the church during the reign of Tsar Samuel at the end of the 10th century and its completion around the middle of the 11th century by Archbishop Leon (1037–1056), who also implemented the frescoes. [5].

¹¹ According to Moutsopoulos, [11] the basilica of Hagia Sophia [in Ohrid] existed during the reign of Tsar Samuel (976–1014). It was probably founded during the reign of Boris, at the end of the 9th century. After the defeat of Samuel's successors in 1018, Vasileios, the Byzantine Emperor, thrashed the Patriarchate of Ohrid and established an Archdiocese. During the time of Archbishop Leon, the basilica had been repaired. In the years of Komnenos, i.e. in the 12th and 13th century, alterations on the facades of the basilica had taken place. At that time, little domes on each side of the chancel were added, as well as to the western part of the temple [11].

3D digital approach of the form of the Cathedral of Taxiarchis Archangel Michael, at the southeastern citadel, since:

- Chronologically, it precedes, the construction of the Christian Cathedral in Ioannina, dated during the reign of Michael A' Komnenos Doukas, for which it constituted, probably, a model.
- It belongs to the type of the *vaulted basilica with a dome*, the type which we assume that the Christian Cathedral, constructed during the reign of Michael A' Komninos Doukas, also followed.
- The specific landmark had been also built on a pre-existing *basilica*, perhaps Early Christian [5, 11].

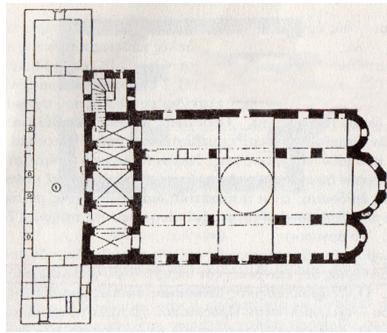


Fig. 1. Hagia Sophia in Ohrid, North Macedonia. Late 10th century. Plan view. (Source: Gioles, 1987, p. 60)

5.2 Characteristics

Orientation

In the Byzantine temple, the position of the sun in the middle of the morning-time on the day of the temple's celebration is chosen as the building's orientation axis. This axis is, of course, largely identical with the point of sunrise, i.e., the east [14].

Length, Width and Height of the Building

- If we take into account the dimensions given by Evliya Celebi for Fethiye mosque of 1670 “sixty feet wide and one hundred [feet] long” [7, 15].
- If we assume that until then the Byzantine temple still exists, even in ruins, next to Fethiye, then we must also assume that Fethiye, if not larger than the Byzantine temple, in order to symbolize the imposition of the Muslim on the Christian, would certainly be of a similar scale, both in plan view and in vertical section.
- It is also very possible, as already mentioned, that the mosque had already incorporated a large part of the pre-existing Cathedral.

Consequently, we will make the assumption that the Christian church would be similar in size to Fethiye mosque building that existed until 1795, as far as it concerns the plan view, i.e., approximately 5.40 m wide and 9.00 m. long,¹² and the height as well, i.e., approximately 9,5 m. for the building and 23.5 m. For the bell tower.¹³ In addition, in order to approach the probable form of the Christian temple, we must take into account the proportions of other parallels of this period as derived by Moutsopoulos [11] Filov [4] and Boskovic-Tomovski [2].

6 3D Digital Model Development

6.1 Reasoning

Developing the 3D digital model for the Byzantine Cathedral of Taxiarchis Archangel Michael has been a great challenge for the specific phase of the Postdoctoral Research Project due to the **fragmentary character** of the available data. This is exactly the reason for which the 3D digital representation of the Christian temple has been chosen to be abstractive, in order not to impose the researcher's point of view but just imply the form of the building by applying, at the final stage of work, the architectural typology data of Middle and Late Byzantine period, intending, thus, to activate the imagination of the recipients, i.e., the people who will visit the website or will make use of the QR tags set in the physical space of the city.

Concluding, a minimalistic optical approach of the past has been the axis of the research.

6.2 Methodology

Basic condition for the 3D digital model development has been its integration in a 2D map of the city of Ioannina, by georeferencing it. Under this perspective, the plan view of Hagia Sofia in Ohrid¹⁴ should be inserted in a Geographical Information System, to be georeferenced and, additionally to acquire an attribute table furnishing the visitor of the G.I.S. with all the necessary information. At a successive stage of work the georeferenced plan view would form the basic image for the 3D digital model development.

Data

Remote Sensing Imagery

A physical color ortho-image of the city of Ioannina has been considered to be the optimal choice for the georeferencing of the 3D digital model's plan view, combining

¹² If we take into account Evliya Celebi's report in 1670 for Fethiye and Aslan Pasha mosques dimensions and compare the specific sizes to the ones as derived from architectural plans of modern times, always having in mind that the existing Fethiye mosque comes from its last construction phase, i.e., after 1795.

¹³ We could accept that the bell tower, as an architectural element with symbolic dimensions in the Christian churches, corresponds to the architectural element of the minaret in the Muslim mosques.

¹⁴ Plan view-model for Taxiarchis Archangel Michael Cathedral.

the characteristics of the image, i.e., the optical realistic representation of the city, with those of a map, i.e., the georeferencing and metrics info.

The ortho-image has been provided by *Hellenic Cadastre*¹⁵ (Fig. 2) [18] for exclusive use in the framework of the specific Postdoctoral Research Project implementation. It consists of 132 sub-ortho-images, type LS025, dating in 2015, at a resolution of 25cm, georeferenced at *EPSG:2100-GGRS87/Greek Grid-Projected* georeference system.

Byzantine Cathedral Plan View

The plan view of the Byzantine temple of Hagia Sofia in Ohrid [5] has been the starting point for the 3D digital model development (Figs. 1 and 3).

Software

The “open access to culture” concept has been the axis of the Postdoctoral Research Project. Under this reasoning only free software has been chosen:

- The G.I.S. development has been implemented by making use of the *QGIS* free software [20].
- The 3D digital model development has been implemented by making use of the *SketchUp Make 2017* free software [21].



Fig. 2. G.I.S. screenshot. The Castle of Ioannina city. The *Hellenic Cadastre* ortho-image is the basic imagery for georeferencing the Byzantine Cathedral plan view. At the right bottom corner of the castle is the southeastern citadel of the Castle where *Taxiarchis Archangel Michael* Cathedral and *Fethiye* Muslim mosque are located. (Imagery source: The *Hellenic Cadastre*. Copyright © *Hellenic Cadastre*) Digital processing by Athina Chroni.

3D Digital Model Development

At a primal stage of the 3D developing, the G.I.S. imagery digital product, resulted from merging the ortho-image and the architectural plan view-prototype for the Byzantine Cathedral, has been inserted in *SketchUp* software.

¹⁵ The imagery has been provided by the *Hellenic Cadastre* for exclusive use in the framework of the specific Postdoctoral Research Project.

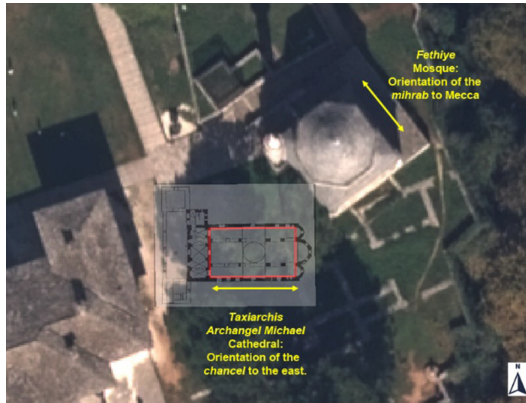


Fig. 3. G.I.S. screenshot. Top view. Detail of Fig. 2. The *Hellenic Cadastre* ortho-image is the basic imagery for georeferencing the Byzantine temple plan view. The red rectangle represents the digitized polygon, which was created for georeferencing the plan view of Hagia Sofia in Ohrid, used as a prototype for Taxiarchis Archangel Michael Cathedral, which should have had its *chancel* oriented to the east, while Fethiye mosque has its *mihrab* oriented to Mecca. (Imagery source: The *Hellenic Cadastre*. Copyright © Hellenic Cadastre) Digital processing by Athina Chroni.

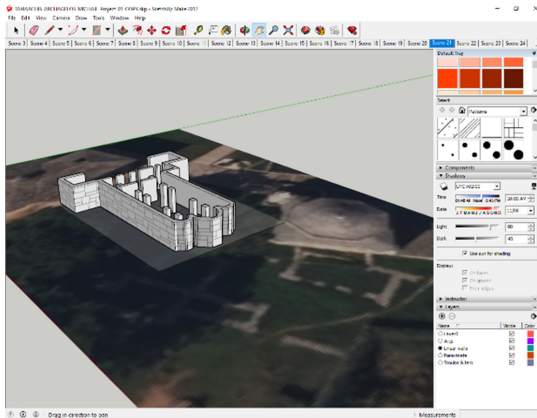


Fig. 4. *SketchUp* software screenshot. Masonry texture on the walls of the Cathedral. Oblique view of the Byzantine Cathedral’s 3D digital model as developed by making use of the G.I.S. imagery digital product. The 3D digital model has been georeferenced. (Imagery source: The *Hellenic Cadastre*. Copyright © Hellenic Cadastre) Digital processing by Athina Chroni.

Taking into account the fact that stone is, over time, the basic building material of the wider area, whether for public or private buildings, secular or religious,¹⁶ the rendering of the texture of the masonry was chosen to represent the structure of the temple’s wall (Fig. 4).

¹⁶ As evidenced by corresponding buildings or buildings’ relics of the Ottoman period. It should be accepted as highly possible that the same data might apply for the 13th century as well, i.e., estimated period of construction of the Byzantine Cathedral.

An additional component for the representation of the specific temple under research, has been the issue of shadows and lighting: the choice focused on the early morning hours, during which the sun rises and the first part of the church building to illuminate is the chancel, which, in turn, and vice versa, indicates the point of sunrise. As a result, 08:00 UTC for Ioannina has been chosen,¹⁷ more specifically, the position of the sun at this time for the 8th November, the name day of Taxiarchis Archangel Michael, Protector of the Cathedral.

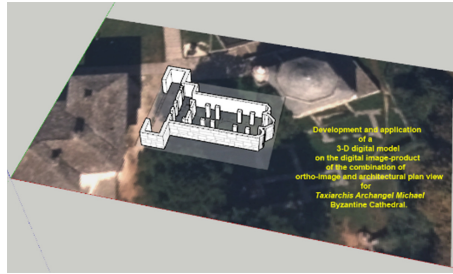


Fig. 5. *SketchUp* software screenshot. Oblique view of the Byzantine Cathedral's 3D digital model as developed by making use of the G.I.S. imagery digital product. The 3D digital model has been georeferenced. (Imagery source: *The Hellenic Cadastre*. Copyright © Hellenic Cadastre) Digital processing by Athina Chroni.

The abstractive rendering of the Byzantine Cathedral's digital 3D model and its virtual integration at the plateau of *Its Kale (Inner Acropolis)* of the southeastern citadel of the city of Ioannina, at the probable site where Taxiarchis Archangel Michael was located in the past,¹⁸ contributes effectively to the study of the buildings complex of the specific site, constituting, at the same time, a motive for further research in the future (Fig. 5).

At a final stage of the 3D digital model development, a virtual walk-through-the-3D-digital-model has become possible by producing an mp.4 digital file under the perspective of offering a more vivid experience to the visitor of the web site which has been developed as a portal to the specific research study.

7 Conclusion

The current physiognomy of Ioannina, as well as the collective memory of its inhabitants has been shaped in a fruitful and creative way thanks to the multiculturalism that has characterized this place over time.

If all the destroyed religious buildings of the Byzantine period of Ioannina were preserved, the physiognomy of the city as a Byzantine center would become clear, an element which is not perceived due to the Ottoman phase that followed, which, to a large extent is still projected as the main characteristic of the city, mainly due to the

¹⁷ Ioannina, Greece: EET (UTC + 2).

¹⁸ Completely destroyed in 1795.

survival of most of the destroyed nowadays, Ottoman period buildings in photographs, paintings, extensive bibliographic descriptions and architectural drawings. The Castle in particular, as a Byzantine castle city, is however an indisputable reality that influenced the next phase of the city.

For this very reason, the components of the city's physiognomy should regain the weight of their cultural contribution.

Moreover, for the fulfillment of an additional objective of the specific research project, that is, community participation and interaction [3], a participatory interactive web-based platform,¹⁹ a virtual museum²⁰ as well as digital signage at the specific sites, where the landmark buildings used to stand, and, also, cultural walks within the city's urban web, related to the project's axis, are being developed, under the perspective of "inviting" the citizens to take an active role in cultural heritage issues.

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¹⁹ IASIS web-based platform: <https://athinachroni.wixsite.com/my-site-1>

²⁰ IOANNINA, 1430–1913 web-based virtual museum: <https://www.artsteps.com/view/5feca5aaf659e68d58a48c8>

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