Georeferenced database for the architectural heritage: a tool for the study and enhancement of the medieval churches in the municipalities of southern Albania

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Abstract - *The municipality of Finiq, as well as the adjacent ones - Delvinë, Sarandë, Konispol, and Dropull - is populated by a large group of sacred buildings dating back to the early Middle Ages. We define the architectonic style of these churches as Byzantine, although actually the component closely related to the architecture of Byzantium is flanked by constructional, spatial, and decorative types peculiar to the Epirus territory. The specificities of this built heritage are mainly due to the geographical location of Epirus as a frontier site between the Latin, Serbian, and Greek areas of influence, at a time of the diaspora of the Byzantine legacy after the fall of the capital of the Empire to western hands in 1204. Currently, this set of sacred architecture, mostly monasteries and hermitages set in scenically significant locations, are being rediscovered, both from the scholarly and the purely touristic point of view.*
What seems to be lacking at the moment is a tool capable of relating the buildings and through this relationship, which can be made explicit through the analysis of constructive, spatial, and stylistic features, promoting critical knowledge among scholars, also with a view to more controlled and conscious actions of protection, and foster their success in the sphere of valorization and promotion.
Such a tool can be configured through a georeferenced database, capable of storing within it data related to direct sources (photographs, two-dimensional processing, models, and 3D point clouds) and indirect sources (documents, bibliographic citations in scientific literature, ancient and modern cartographies). Systematizing this mass of information permits the scholar who accesses it not only a more structured knowledge of the object of study but also an infinitely greater possibility of relating the building studied to other buildings in the area simply by analyzing the relationships that are automatically created within the database.
A relevant example may be the emergence of the Monastery of St. Nicholas in Mesopotam, which presents peculiarities from the points of view of spatial and constructive typology - a single hall with a narthex, four domes supported by a central column, two apses - and decorative apparatuses both sculptural and pictorial. The study of these features, not yet fully understood historically and culturally, can be facilitated by a comparative tool such as the database under study.
In the future, such a formed relational structure can be the basis for further insights that implement artificial intelligence and machine learning processes in order to automate some steps of the cognitive process. Indeed, we know that, given a quantitatively relevant input data, a classification algorithm can be trained and thus can perform tasks that, if tackled by human operators, would be excessively time-consuming. A classification algorithm could be trained to recognize recurring decorative motifs, spatial proportions that deviate from the trend, structural solutions particularly related to a historical era, etc. This tool, in addition to aiding the construction of more structured knowledge on the specific topic, could be a standard of acquisition-analysis-results applicable to other areas of built heritage.

Fig 1 / The church of St. Mary in Peshkëpi is isolated upon a hill in the Vlorë municipality source / courtesy of Arch. PhD Veronica Vona

Introduction - The Albanian territory is historically considered a junction of Europe: a hinge between Greek and Roman influences, then between Norman and Byzantine influences, and finally a bridge between Venetian culture and Ottoman influence. Since antiquity, the culture of these places has shown an extraordinary receptivity to external inputs, materialized in architectural works that, though largely destroyed or tampered with, still manage to testify to Albanian cultural vibrancy. Albania's built heritage consists of Latin, Christian, and Muslim sacred buildings, traditional houses, and public buildings such as theaters and baths, tombs, etc.
However, it should be noted how constructively and stylistically the Albanian buildings of the late Middle Ages are influenced by multiple architectural currents, not solely traceable to the Byzantine matrix: Venetian, Slavic, and Apulian influences. The result of such receptivity is demonstrated by some monuments, especially sacred buildings referable to the 12th, 13th, and 14th centuries. Certainly, because of its antiquity, its importance in the past, its scenic value, and its impressive stratifications, the Monastery of St. Nicholas in Mesopotam represent an exceptional case study. To this day, only the church and a few fragments of the imposing surrounding wall, originally 333 meters long and defended by seven towers, one of which survives today in the bell tower, survive of the monastery. The church, or katholikon, is an externally compact building, but one that conceals great internal articulation. Of the medieval masonry some parts have been lost, rebuilt between the 18th and 19th centuries in the presumed original conformation except for the apse wall, where the medieval double exedra has been replaced by a single apse. Inside, the succession of spaces betrays a deep connection with coeval Byzantine architecture, especially in the articulation of the narthex, naos, and bema, but inserts some new elements such as the subdivision of the naos into four bays corresponding to as many domes. This particular binary conformation necessarily reverberated, at least until the 18th-century destructions, even in the double apse. The diaphragms dividing the naos from the narthex and bema are supported by four arches, each supported by columns with capitals decorated with motifs akin to the style we can find all the way to present-day Arta[1].
Other significant buildings comparable to the stylistic features of St. Nicholas are the church of St. Trinity in Berat, the monastery of St. Mary on the island of Zvërnec, the church of St. Mary in Peshkëpi, as well as the small church in Marmiroi. All of these monuments have in common with Mesopotam an early edification

1 / For an essential bibliography about the Monastery of Saint Nicholas:
Macchiarella, G. (2011). Un caso a sé: San Nicola di Mesopotam (Albania). Derosa, L.; Gelao, C. (a cura di),Tempi e forme dell'arte: Miscellanea di studi offerti a Pina Belli D'Elia, Foggia: Grenzi, 123-135.
Triggiani, M. (2016). San Nicola di Mesopotam, Correnti culturali adriatiche, in «A mari usque ad mare» Cultura visuale e materiale dall'Adriatico all'India, Scritti in memoria di Gianclaudio Macchiarella, a cura di Guidetti M. e Mondini S., Edizioni Ca'Foscari.

between the 12th and 15th centuries, a landscape location of some importance, and many elements of connection with Byzantine architecture of Eastern origin. However, each of these churches interpreted the spatial arrangement of the rooms differently, always playing freely and inventively with the composition of domes and barrel vaults, wall partitions, and free-standing columns. All of these cases express the problems and potential of an architectural and archaeological heritage of extraordinary interest that is still neglected today, both from the point of view of research and from the purely tourist one. Often these churches, both intact and archaeological ruins, are in need of in-depth study, survey, restoration project, and enhancement strategy.

Research question

The objective of this research is to attempt to establish the best method in order to trigger the process of heritage study, preservation, and enhancement discussed so far. Therefore, in relation to widespread heritages with a high risk of testimonial loss, I have identified geo-referenced databases, more specifically GIS systems, as a viable tool at least for the first phase of the study.

This tool makes it possible to associate the classic structure of a relational database, which allows dynamic querying of its contents, with a georeferenced CAD digital drawing component on the globe. Such associations can relate monuments (or parts of them) not only through classical historical or descriptive data but also through spatial data (location on the territory, orientation, morphology, stylistic features, constructional ones, state of preservation, etc...).

Albania's medieval churches have already been the subject of studies: the journal Monumentet, internal to the Albanian Ministry of Culture, has been investigating the country's historic architecture for decades, as have numerous contributions from European scholars on the subject. The modalities adopted so far, however, are of analysis, even in-depth and multiscalar, of the single case; rarely do we see the systematization of a plurality of buildings, according to typological, thematic, chronological, constructive, etc. criteria.

Let's take an example: a hypothetical researcher finds in the church of St. Nicholas in Mesopotamia a capital with an interesting conformation, which then appears as an anomalous compositional type compared to the corpus of standard capitals found in the church and buildings known to the researcher. With the present state of the art, the scholar would have to search manually for all the papers, articles, monographs, and restoration projects that have been written on buildings dating from the same era as St. Nicholas' construction, within a radius of several hundred kilometers, if not go himself to view these buildings, with all the difficulties of access that there might be. Once he found a significant specimen, he would write about it in his scientific paper, and then publish it. A hypothetical second researcher with a similar problem to solve would encounter the same difficulties as the first, minus the above specimen, which he would have found manually anyway by searching the scientific literature on the subject.

This paper seeks to find a system to bypass the limitations that this type of research might encounter in comparing distant buildings and architectural details, encouraging collaboration and sharing of results among scholars.

Methodology used

Heritage GIS is an experience that has already been tried and tested, at least in Italy, both for individual monuments of exceptional importance (see the GIS prepared to analyze the masonry and deterioration phenomena of the Tower of Pisa) and for widespread heritages affected by natural disasters (e.g., the dynamic filing system for specialized buildings within the crater of the 2012 Emilia earthquake). All these experiences have led to differentiated results, yet highlighting a common advantage: the system's ability to be dynamic, adapting in real-time and automatically according to the data contained within it. Especially in the field of historical studies, this dynamism and automatism are almost unheard of; in almost all cases, the scientific literature privileges the case study analyzed in depth, whose connection with other case studies is left entirely to the researcher's cultural background and critical spirit. Obviously, the proposal of an automatic system does not attempt to replace in toto the cognitive process of architectural historians, so much as to flank them in the more repetitive parts or to empower them in wide-ranging thematic research; fundamentally, the critical culture of the scholar continues to be the foundation of good research.

Geographic Information System (GIS) is a computerized information system that enables the acquisition, recording, analysis, display, return, sharing, and presentation of information. In addition to these features,

Fig2 / Church of the Monastery of St. Nicholas in Mesopotam: capital of the internal narthex and two sculpted elements of the exterior façade source / the author

which are common to all database systems, it is capable of associating data with their geographic location on the earth's surface and processing them to extract information. Its main use is in digital mapping, graphing, and the study of human and natural terrestrial phenomena. GIS makes it possible to relate different data together on the basis of their common geographic reference so as to create new information from existing data. GIS offers extensive possibilities for user interaction and a set of tools that facilitate its customization and adaptation to the user's specific problems. Initially, this technology was born to manage spatial planning, but since the early 2000s, a number of studies have pursued innovative projects that intertwine technological novelty with the field of heritage conservation. A breakthrough was given by Paolo Salonia, a CNR researcher, who first attempted to intersect the fields through the ARKIS (Architecture Recovery Knowledge Information System) project. The system simply substituted the territory for the investigated architectural surfaces, which could now be mapped by CAD drawing, thus generating an enrichment of dynamic, implementable, and modifiable cognitive layers. As can be guessed, this technique does not handle a set of cultural assets in a single platform but allows for in-depth knowledge of individual parts of the asset. Similar experiences were later made at large restoration sites, such as that of the Tower of Pisa undertaken in the 1990s. In this case, GIS vector mapping was intended for a deeper understanding of the constituent materials of the tower and the degradation pathologies that afflicted it. In more recent years we have seen the emergence of SIGEC, then SIGECweb[2], which is a web-based platform that manages the entire flow of cataloging, from the production and dissemination of cataloging standards to the assignment of unique catalog codes to the cataloging of assets, to the publication of catalog cards for use on the General Catalog of Cultural Heritage website. The platform is managed by the Central Institute for Catalogue and Documentation, an entity of the Italian Ministry of Culture. This system, which is integrated into official heritage cataloging processes, allows a nationwide allocation of all types of assets and thus also a dynamic consultation of them, according to queries chosen by the user.
However, the latest generation is the use of 3D GIS in heritage conservation. Three-dimensional GIS is the natural evolution of the two-dimensional system. Developed and optimized for large spatial areas, it is capable of adapting CAD graphics to the articulated pattern of a three-dimensional mesh. Through some experimentation conducted within the Department of Architecture in Ferrara, a manual (Zuppiroli, Formigari, Santilli, 2022) has been prepared that allows one to operate with the same system on architectural surfaces. The same advantages that we could have with ARKIS, here are amplified by the possibility of studying and managing everything that is not visible in two dimensions, that is, projections, decorations, changes of plane, to put it briefly: architectural language.

Results

The proposal of this paper is to build a platform that manages to integrate the benefits of two-dimensional spatial GIS with the 3D mappings of architectural GIS. This would work through multiscalar relationships: a set of geometric entities geolocated on the Albanian territory carry within them metadata, some descriptive, some graphic, and some additional three-dimensional GIS files linked to the general database. In this way, it would be possible to have an organic body of information capable of generating automatic relationships among the data.
An experimental version of this system has already been tested by the Ferrara Department of Architecture through a research agreement with Gallerie degli Uffizi for the study and restoration of the Boboli Garden in Florence. For this project, a GIS of the garden was prepared, in which the different categories of elements (fountains, sculptures, trees, paths, walls, etc.) were represented by as many layers. In the case of the statues, fountains, and architectural elements, a detailed survey campaign was then carried out that had textured three-dimensional meshes as output. These were then imported into 3D GIS software to map their degradation pathologies. The final goal was then to be able to link the individual three-dimensional files to the first two-dimensional GIS, that is, to manage the morphological and textural data of each individual element from the general geolocated file.
The proposed system, thus integrating GIS technology at various scales, could provide a fundamental aid to the knowledge of the heritage under investigation. The first operation should be the identification of the monuments through the files already made by the Ministry of Culture, geolocation of them, and the uploading of ancient documents and scientific literature dealing with the subject. Then the churches should be surveyed through the technologies that allow obtaining of three-dimensional data (laser-scanner, photogrammetry), or the surveys already made by others should be

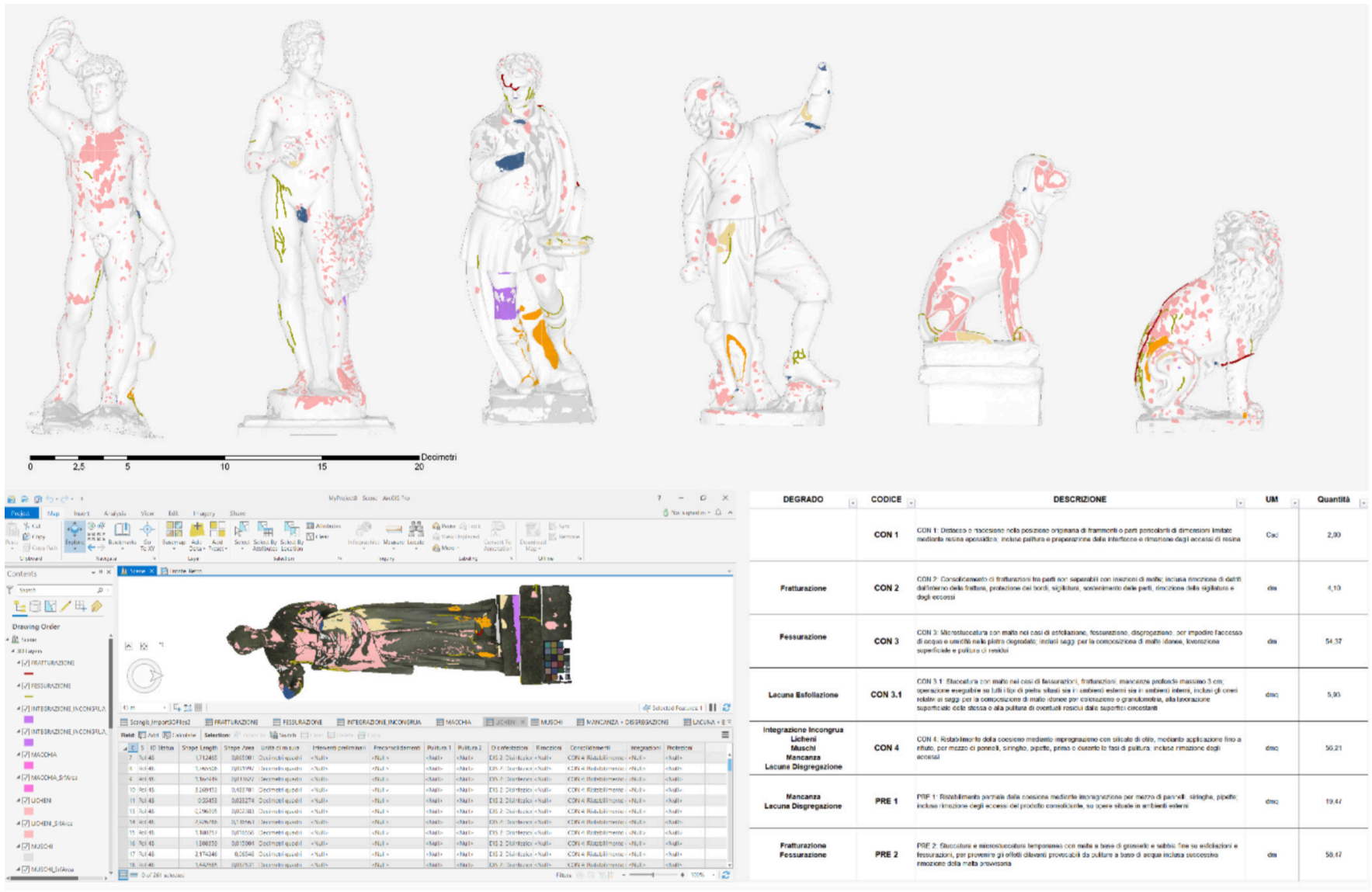
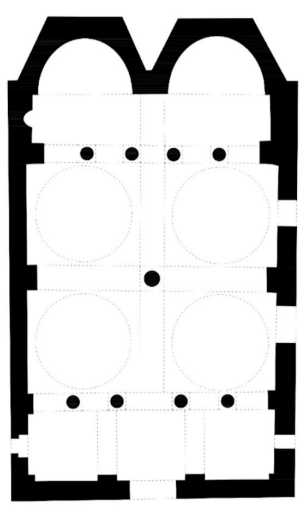
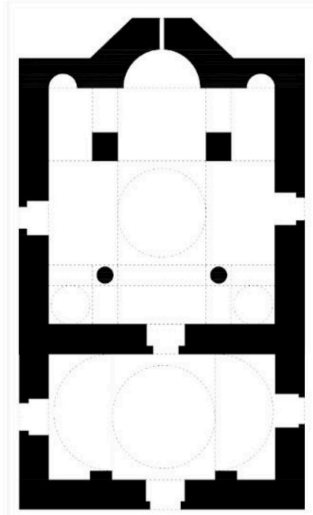


Fig3 / The 3D Gis to investigate the restoration interventions on some statues of Boboli Garden in Florence
source / Department of Architecture of Ferrara, Uffizi Museum of Florence

2 / http://www.iccd.beniculturali.it/it/sigec-web.





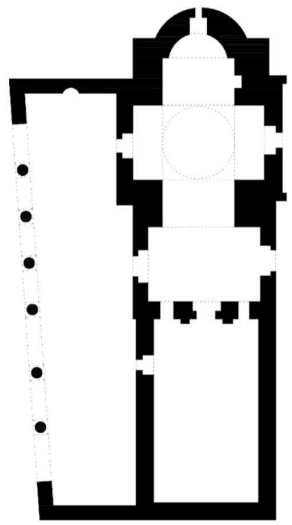



Fig4 / Three possible objects of study: St Nicholas in Mesopotam, St. Trinity in Berat, and St. Mary in Zvernec
source / the author

acquired. Having this information available, the operator would be able to describe individual buildings by filling the database fields with information on spatiality, construction techniques, stylistic features, historical data, etc. Already with this type of implementation, the tool could offer interesting research insights that could be easily obtained: for example, the spread of the longitudinal plan versus the central plan, the presence of a narthex or atrium, the use of columns or septa as vertical support. Each of these queries could be easily verified on the implemented data and could have unpublished answers related to little-studied spatial areas or time lapses.

Conclusions and Recommendations

We have seen how a GIS system that implements a general macroscale of collective vision and a scale of detail that investigates architectural surfaces can automatically generate benefits to the knowledge of built heritage, in this case, Albania's medieval sacred buildings.
The platform designed in this way would then have endless possibilities for expansion, perhaps the most interesting of which involves artificial intelligence. A GIS database is not intelligent per se; it can only be investigated with predetermined queries. Artificial intelligence, on the other hand, can be trained in recognizing patterns, deviations from the mean, etc. Given a large number of records within the dataset, a machine learning algorithm might be able to recognize the same proportional pattern of a plant in other buildings that a human operator would not have thought to consider. The possibilities for future use of these technologies on heritage, however, are subject to the need to be able to provide a homogeneous and well-structured body of data to the system. The topic of new technologies in connection with the critical nature of research in the historical field is a thorny one and is always in danger of polarizing opinions. While there is no question that the final word on the results of research is the scholar who carries it out, it would be counterproductive and not at all in step with the times not to seek the help of technologies in those areas that, in quantity or precision, would be unsolvable by human hand.

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