The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-9-2025
30th CIPA Symposium “Heritage Conservation from Bits:
From Digital Documentation to Data-driven Heritage Conservation”, 25–29 August 2025, Seoul, Republic of Korea

Bridging the Past and Present: A GIS-Based System for Managing Ankara’s Multi-Layered Urban Heritage

Zeynep Buket Üstün [1], A. Güliz Bilgin Altınöz [2]

[1] METU, Department of City and Regional Planning, 06800 Çankaya, Ankara – zustun@metu.edu.tr
[2] METU, Department of Architecture, Graduate Program in Conservation of Cultural Heritage, 06800 Çankaya, Ankara – bilging@metu.edu.tr

Keywords: Multi-layered Cities, Ankara, GIS, Documentation, Integration Assessment.

Abstract

Cities that have been continuously inhabited and embody the spatial traces of historical continuity are defined as “multi-layered”. The remnants of historical periods and cultures, which constitute the stratified layers of the city and the interconnections among them, contribute to the spatial complexity and identity of multi-layered cities. However, when these remnants are not perceivable or effectively integrated into the contemporary city, the conservation and long-term sustainability of multi-layeredness become increasingly challenging. This necessitates the documentation of historical layers and the synthesis of fragmentary information from diverse sources into a coherent and systematic framework. Thus, the aim is to make the components of different historical periods in various parts of the city known, and to understand and evaluate their relationship with the contemporary city both vertically and horizontally. Ankara, inhabited since prehistoric times and characterized by being a multi-layered city, was chosen as the study area. To produce comprehensive and usable information, Geographic Information Systems (GIS) were utilized. GIS facilitates the processing of complex and voluminous data from diverse disciplinary sources. "**MULAAN▪GIS** [**MU**lti-**LA**yered **AN**kara **GIS**]" was produced by processing historical period components into the database, together with the attributes of the identity areas representing their period. This approach unveiled historical continuities and discontinuities, the physical, functional, visual, and intellectual integration levels, along with the challenges faced by citizens. The historical spatial dataset and integration degrees created in the GIS have the potential to serve as a spatial decision support system on heritage protection, thereby providing an input for spatial plans.

1. INTRODUCTION

Multi-layered towns are continuously inhabited places with physical evidence of historical continuity. The spatial configuration of each historical period, shaped in relation to those that came before, adds to the city's historical, cultural, and physical depth and richness (Bilgin Altınöz, 2021). While the spatial traces of historical layers within the urban landscape may persist physically, functionally, and semantically, changing in subsequent periods, these traces can become obscured due to their disconnection from the contemporary city and their diminished relevance to the citizens. As their places and meanings become obscured in both the urban landscape and for the citizens, the traces of historical stratification gradually disappear over time, resulting in the erosion of the city's multi-layered structure. When the connection between these historical layers and the current urban context is lost, the traces of historical stratification begin to fade, resulting in the erosion of the city's multi-layered structure. As noted by Zancheti and Jokilehto (1997), one of the greatest values of a city lies in its ability to create a continuum between different periods while maintaining its diversity and uniqueness. Therefore, it is essential to protect the integrity of these historical layers within the contemporary urban context to preserve the town's multi-layered character. For the continuity of the multi-layered character of cities, first of all, it is crucial to uncover the spatial traces of historical stratification in multi-layered cities and integrate them with the present-day city and its inhabitants. Comprehensive, accurate, and accessible information on historical stratification is crucial for informed conservation decision-making, which is key to conservation, management, planning, and presentation of the multi-layered character of the city.

In order to ensure the preservation of the spatial traces of historical continuity in multi-layered cities, it is imperative to first reveal, analyze, and evaluate these traces. Subsequently, a series of decisions must be formulated to render them both visible and recognizable within the urban landscape. This process enables their integration into the city's fabric, thereby conferring upon them a sense of significance and relevance. At this point in the research, it is of the utmost importance to transform these data into usable information by spatially structuring them with observations and documents in the existing city together with the data obtained from historical and current written and visual sources from different professions (such as archaeology, history, art history, architecture, urban planning) regarding the physical structure of the city in different periods. Comprehensive, accurate, and usable information regarding the historical stratification of the multi-layered city is essential to support the conservation decision-making process, thereby ensuring the preservation of the city’s multi-layered character.

The majority of cities in Anatolia, having been continuously settled since ancient times, exhibit physical traces of various periods in their historical development processes as distinct layers. However, contemporary urban developments in many Anatolian cities have placed these multi-layered urban landscapes at risk of becoming one-dimensional spaces. Among the many reasons for this, one of the most important reasons is that spatial data on the historical stratification of the city has not been gathered and transformed into usable information; in parallel, awareness of the historical stratification of the city has not been formed and has not been included in spatial decision-making processes (Bilgin 1996; Bilgin Altınöz 2002; Bilgin Altınöz 2014; Bilgin Altınöz 2021).

Ankara, the capital of Türkiye, is a continuously inhabited city rich in layers of history, located at the crossroads of significant roads in Anatolia (Aydın et al., 2005). However, the historical, cultural, and physical depth of the city is not easily recognizable today. A primary reason for this is the lack of compiled spatial data on the city's historical stratification, which has yet to be transformed into utilizable information. Furthermore, this information has not been incorporated into spatial decision-making processes, resulting in a lack of awareness about the city's historical layers among both decision-makers and the general public. To address this issue, it is essential to highlight the traces of historical stratification to foster a greater understanding of their significance among central and local decision-makers and citizens. Accordingly, this study aims to reveal the multi-layered character of the city both vertically and horizontally by bringing data together on different historical periods of Ankara; to understand and evaluate the relationship of the spatial traces of different periods with the existing urban context.

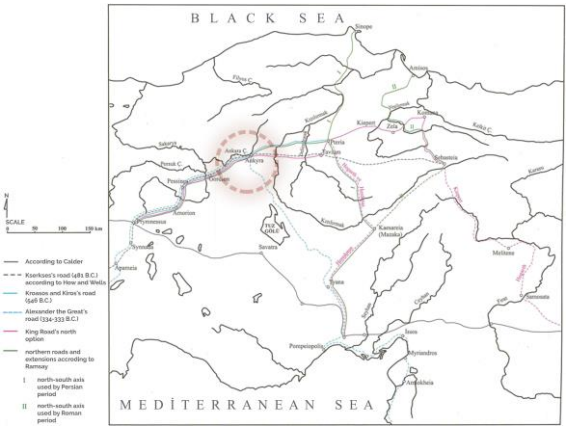

Figure 1. The significant ancient transportation routes passing through Ankara

This process involves collecting, storing, structuring and managing large amounts of complex spatio-temporal data derived from various sources from different disciplines. Geographic Information Systems (GIS) provide an excellent platform and a dynamic environment to manage complex spatio-temporal data to assess relationships between different historical layers (Bilgin Altınöz, 2003). Hence, **MULAAN▪GIS** [**MU**lti-**LA**yered **AN**kara **GIS**], a GIS-based heritage information management system accessible to stakeholders, including experts, citizens, and decision-makers, is established to support the conservation, management, and planning of the multi-layered city of Ankara.

2. METHODOLOGY

Numerous studies and research have been carried out by different disciplines, including archaeology, history, art history, architecture, and planning, on the spatial traces of the various periods that exist within the historical continuity of the multi-layered Ankara. However, the data produced as a result of this research and studies are often found in different sources, disparate from each other. The most significant deficit at this juncture is the absence of a spatial information management system that would facilitate the integration, structuring, spatial association, analysis, and evaluation of data from different periods of Ankara. This phenomenon hinders the recognition of Ankara's multi-layered character. Consequently, it is imperative to integrate multidimensional and complex information on all historical periods of Ankara (Prehistoric, Antique, Late Antique, Turkish-Islamic, Republican) into a spatial framework. This approach will reveal the multi-layered nature of the city to the citizens, thereby facilitating a deeper understanding of the issue. In this context, by structuring the existing data on historical stratification and transforming it into usable spatial information, a GIS environment that can be understood and accessed by different stakeholders, especially citizens and decision makers, has been created; it is also aimed to contribute as a decision support system for the conservation and planning process.

2.1 Archival and Literature Study for the Historic Layers

As a result of the literature and archive study, data from written and visual sources produced by different disciplines regarding different periods of the city and data obtained from fieldwork were brought together. While the data from the literature was used to spatially document the historical layers together with their different components, the on-site observation was carried out to reveal the degree of integration of the different layer components with today's city and citizens.

A comprehensive data set was compiled through detailed analysis of diverse documents, including books, articles, archives, and historical city maps. Furthermore, an examination of the works of ancient travelers was undertaken to ascertain information regarding antiquity. A thorough investigation into past and ongoing archaeological research was conducted to enhance the understanding of the archaeological layer. A preliminary analysis of the planning processes and decisions was conducted to identify the factors that precipitated the alterations to the layers and their legal status, which may have implications for the proposed integration strategy. Moreover, data and documentation from the Ankara Ministry of Culture and Tourism, as well as the Cultural Inventory Map on the ministry's website—which disseminates periodic information on cultural assets within Ankara—were instrumental in the development of the database. Aerial photographs from the METU Map and Plan Documentation Unit were also utilized as a source to identify continuities and changes in the urban built environment and historical layers.

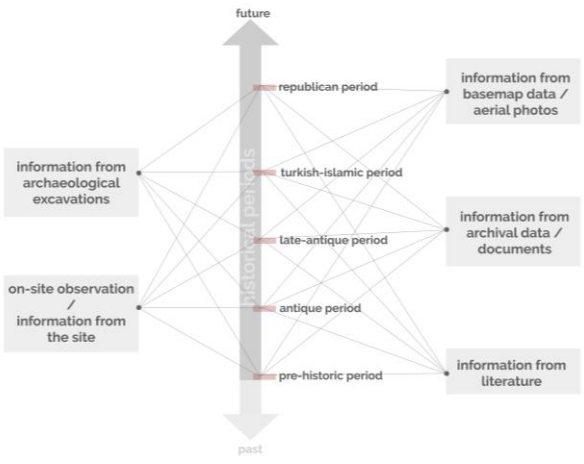

Figure 2. Different information sources for the documentation of historic layers

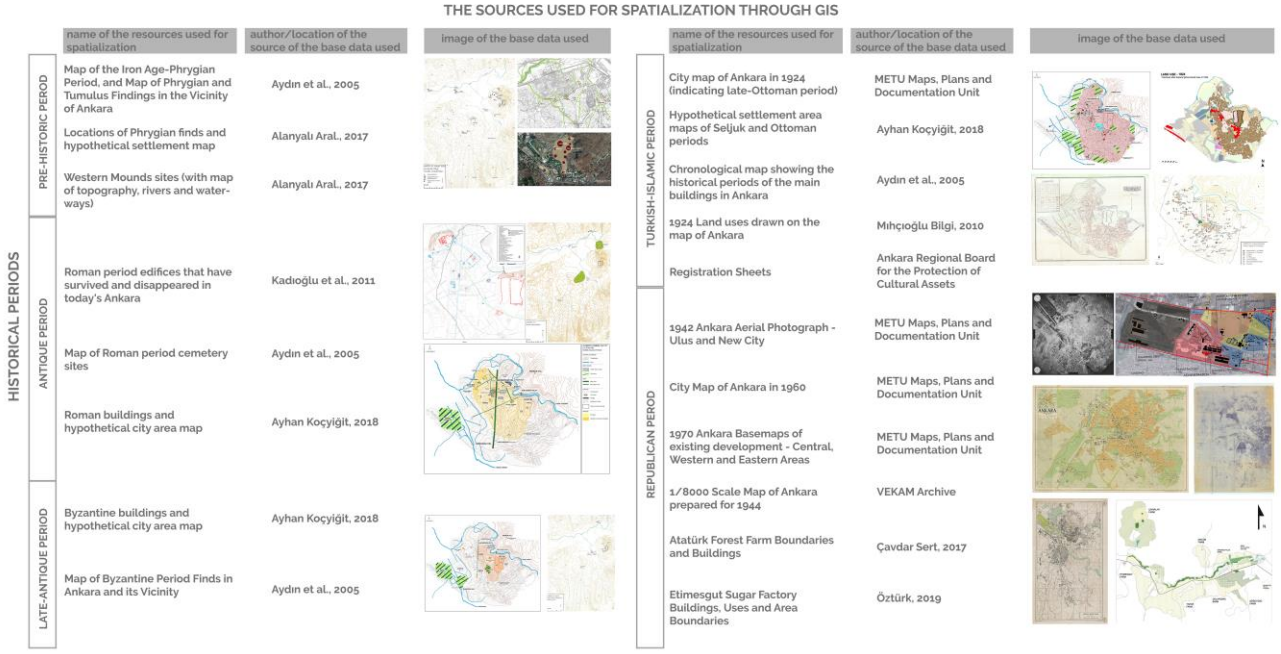

Figure 3. Sources which have spatial information/data for each historical layer of Ankara

2.2 Site Survey in the Determined Identity Areas of each Historic Period

Through the literature and archival survey, the identity areas of each historic period were determined by considering their functions, significance and values for the city and citizens. Subsequent to the determination of the identity areas of each historic period through the diachronic mapping of the layers in GIS, the site survey was conducted in order to understand the integration levels with the city in physical, functional, visual, and intellectual terms. In the site survey stage, the requirements for integration, which have already been defined, were checked for each identity area. In this way, the problems of disintegration and discontinuities were revealed.

Figure 4. Residential tissue in a derelict state (top), Roman Bath remains surrounded by walls, isolated from the city (below)

2.3 Geographic Information System

The database for multi-layered Ankara was designed, and a database model was produced to include different layers and their attributes according to the components of all periods. First of all, the conceptual model of the project was defined, and the layers to be produced were decided by considering the components of the historical period; in this way, the GIS project was defined, and data was processed into the GIS according to different degrees of reliability from the sources. In addition to documenting, analyzing, and presenting information as spatial data, the GIS environment also enables integrated analysis and evaluation by linking all information with each other. For this reason, the integration of Ankara Historical Layers with the city was developed as a GIS-based project and designed as a flexible and adaptable system that can adapt to future changes and developments. GIS played an important role in this study, both for documenting and processing complex spatial data, and for its flexible nature and openness to change and updates.

3. THE FORMULATION AND STRUCTURE OF MULAAN▪GIS

Following the multi-layered nature of Ankara, a systematic data collection is conducted by using a variety of historical and contemporary visual and written sources, along with site surveys, taking into account all the historical layers of Ankara, including Prehistoric, Antiquity, Late Antiquity, Turkish-Islamic, Early Republican, and Late Republican periods. The data is then structured within **MULAAN▪GIS**, incorporating key components from each historical period.

3.1 The Scope of the MULAAN▪GIS Geodatabase

All data concerning the natural environment, built environment, and archaeological component features of all historical layers of the city were systematically arranged in the database using ArcGIS software. In order to evaluate their integration with the

city and its inhabitants, the degrees of physical, visual, functional, and intellectual integration were systematically processed into the database by structuring the data from on-site observation.

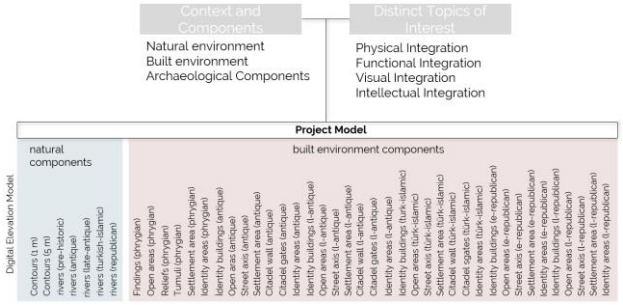

Figure 5. Project model containing integration dimensions of the historical layers and the relationship between contexts

3.2 The Mental Model of MULAAN▪GIS

Before entering the data into the database, the collected documents such as aerial photographs, city maps, thematic maps of archaeological sites, CAD-based drawings, etc. were georeferenced using 1984 World Geodetic System (WGS84 UTM 36N) coordinates. As mentioned earlier, the main components for the historical layers in the project are the natural and built environment components. The components digitized in GIS for each historical period of the city were determined as the main buildings that best reflect the period, the main transportation and circulation system of the city, the main open public spaces, and the boundaries of the city (the area where the settlement spread or was bounded). However, while the natural components are the contour lines, rivers and streams of each period, the built environment components also differ according to historical periods. For example, the components that have survived from the prehistoric period (Phrygian Period) are artifacts, reliefs or tumuli, while the components for other historic periods are defined as identity structures.

Therefore, the built environment components for the prehistoric period are defined as findings, open spaces, reliefs, tumuli, settlement areas and identity areas. The built environment components for the Antique, Late Antique and Turkish-Islamic periods are identity structures, open spaces, street axes, castle wall, castle gates, settlement area and identity areas, while for the Early Republican and Late Republican periods, identity structures, open spaces, street axes, settlement areas and identity areas were created in the database as different feature classes.

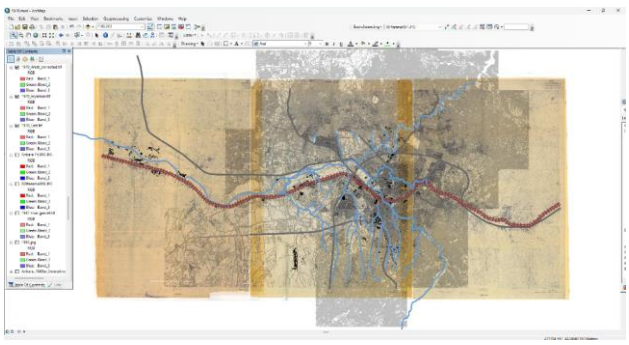

Figure 6. Spatialization of historical periods based on the georeferenced basemaps obtained via archival study

In the GIS environment, which enables the preparation of diachronic maps and the structuring, storage and visualization of complex information about the structures, many attribute data were processed for the historical period components. For buildings and periodic identity areas, the name, category, function, period, current state of existence, source of information, physical and functional continuity levels, physical, functional, visual, and intellectual integration levels were entered into the attribute table. For the main axes, the name, function, period, hierarchy, current state of existence and source of information were entered into the attribute table, while for the main open spaces, the name, type, period, category, function, current state of existence and source of information were entered.

As the data entry process is completed, the system became ready for analyzing, querying, and visualizing the multi-layered spatio-temporal data to produce "plano-volumetric" (Bilgin Altınöz, 2002) maps and assess the integration of different historical periods within the modern urban context. When these components of all historical periods are layered on top of the existing city and their integration levels are entered into the database, areas of historical continuity, areas where continuity is disrupted, multi-layered cultural heritage areas, identity areas that best reflect each period of the city and their integration levels with the existing city are revealed (Üstün, 2024).

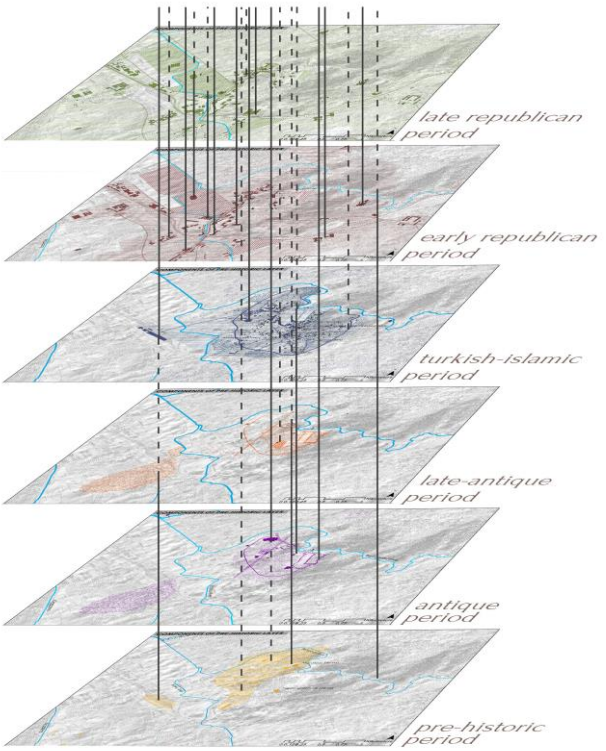

Figure 7. Revealing continuities and discontinuities through the creation of the ‘Plano-Volumetric’ view of the city and defining identity areas of multi-layeredness

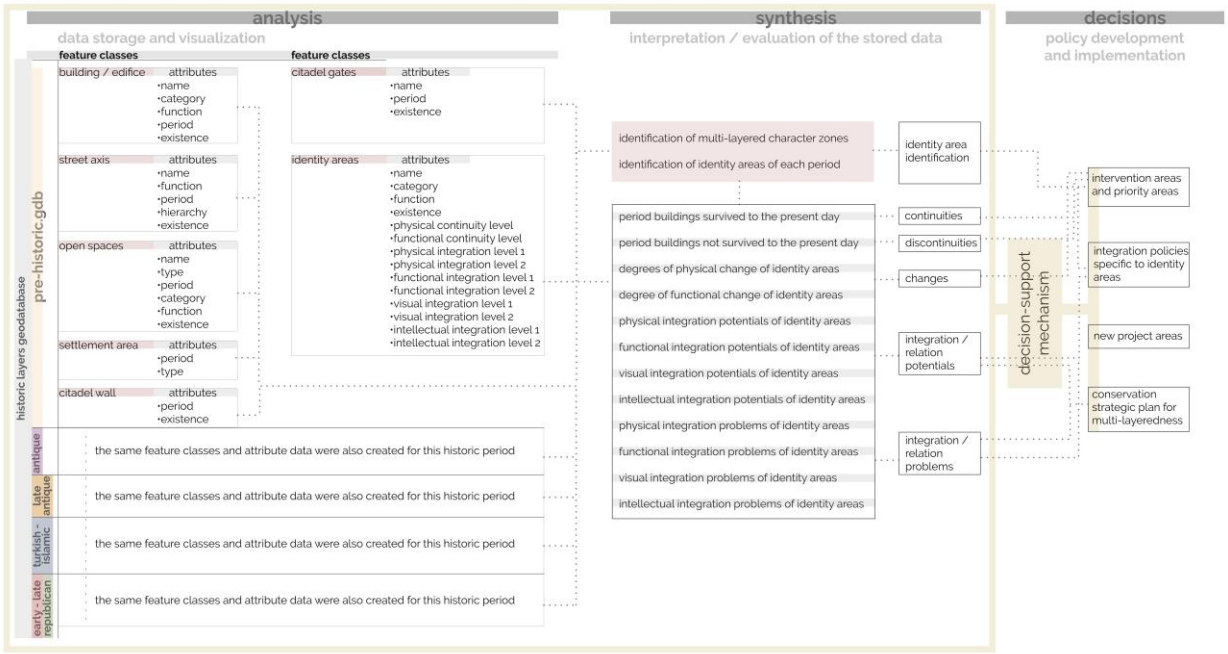

Figure 8. **MULAAN▪GIS** [**MU**lti-**LA**yered **AN**kara **GIS**] Database Model

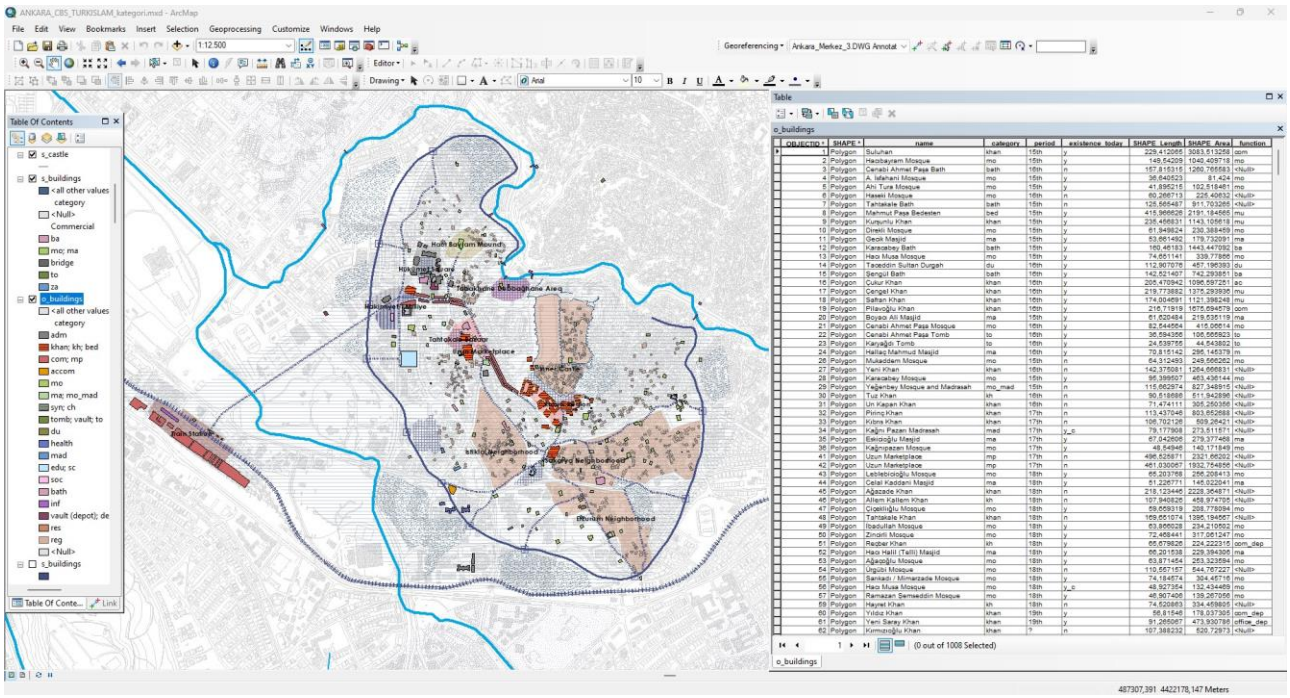

Figure 9. The attribute table used for the “building feature class” in the data entry phase, an example from the Turkish-Islamic Period

3.3 Analysis and Evaluation of the MULAAN▪GIS Data

The data processed into the GIS environment with attributes for each historical period have been effective in determining multi-layered areas and periodic identity areas. The definition of an identity area in the field of urban archaeology is twofold. On the one hand, it is perceived by the continuity it provides. In other words, they are the areas where the components of each historical layer are most concentrated. Therefore, identity areas are witnesses of historical periods in which historical continuity is essential. As stated in the Mental model, layers are defined as the periods that change the form of the city over time with transportation, architecture, urban layout, etc. starting from the early period to the present day. Each layer is based on the main components of the city, such as urban form, important streets, monumental buildings, borders, access to the city and so on. When the components overlap with each other, the intersection areas of all periods are defined as “identity areas” in terms of multi-layeredness. In short, these are the areas that best represent the multi-layered character of the city. On the other hand, each historical layer may have its own identity areas. In this case, the areas that best represent their own period in terms

of their functional and physical characteristics and their importance for citizens are called identity areas. In this case, the components of the city that function as “symbols” for its period are taken into consideration. In both definitions of identity areas, it is noteworthy that the identification of identity areas in the urban landscape requires an in-depth understanding of each historical period. Moreover, while some layers manifest themselves as identity zones at the “building/monument scale”, the identity zones of some layers may emerge at the “area/neighborhood scale” in today's urban context (Eren, 2023).

In this context, a combined evaluation of the database and the literature review reveals identity areas that are significant for the city and its inhabitants. In these areas, continuities, discontinuities, functional and physical change degrees have been revealed. The physical integration of these identity areas was evaluated and graded according to the sub-headings of access and integrity, functional integration according to use and user, visual integration according to visibility/perceptibility and visual attraction, and intellectual integration according to the sub-headings of providing information, presentation and interpretation of information to the city. Consequently, the extent to which these areas are integrated with the city and its citizens according to various integration criteria was determined.

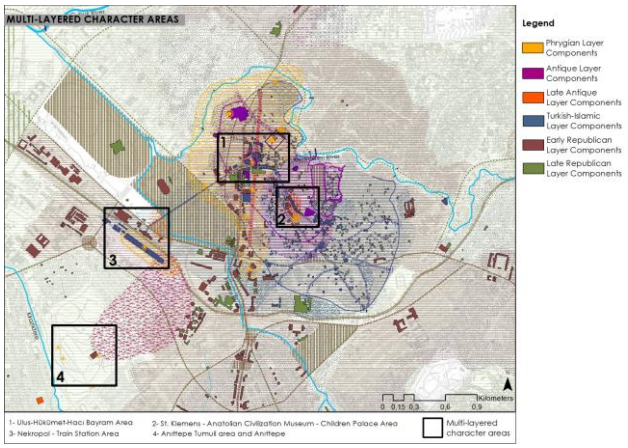

Figure 10. The multi-layered character areas of Ankara, where most of the historic layers intersect

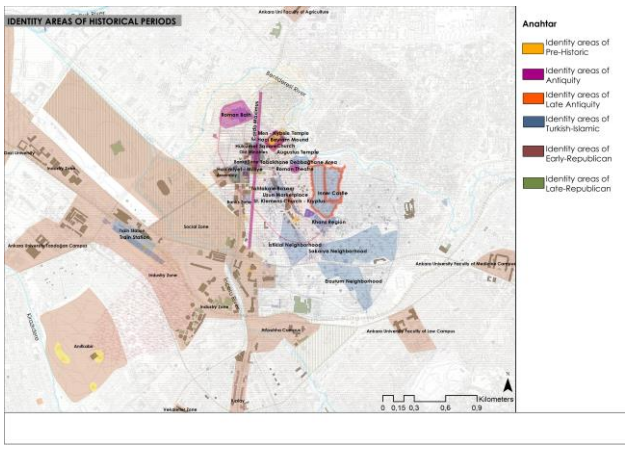

Figure 11. Identity areas of each historic period

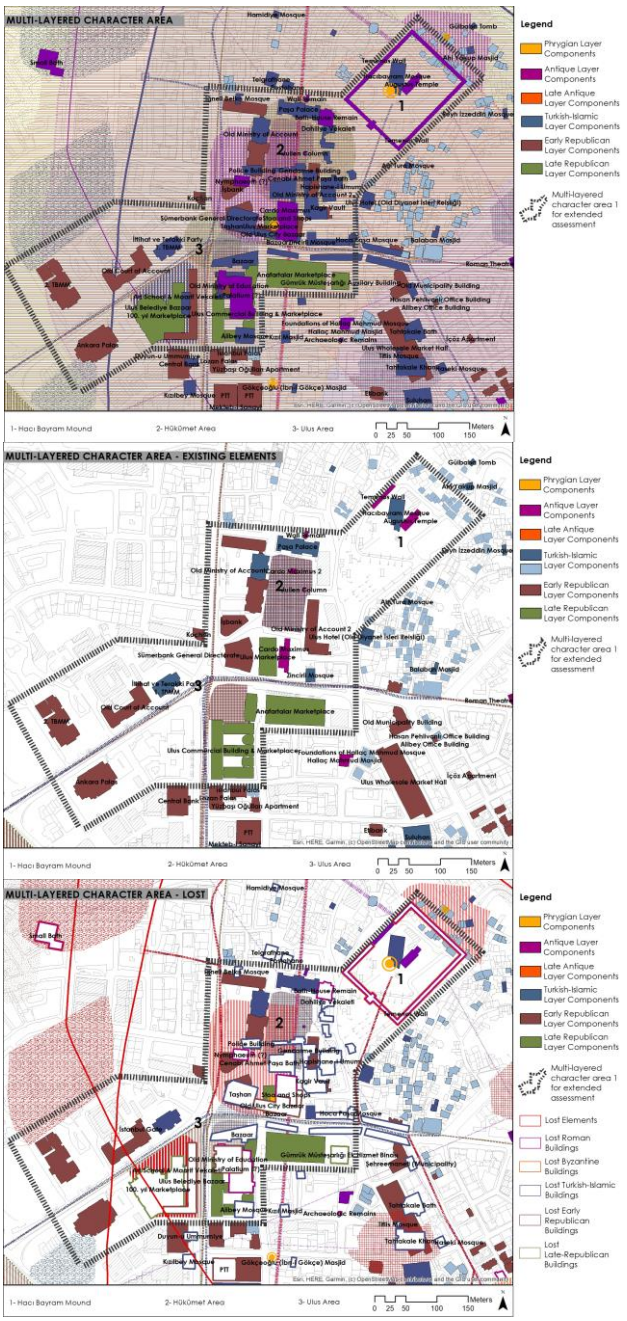

Figure 12. Multi-layered character areas revealed by diachronic mapping (top), The components of all historic layers which have survived today (middle), The components of all historic layers which have been lost (below)

3.4 Presentation of the Results and Critical Findings

The integration of data at varying scales within a Geographic Information System (GIS) facilitates the analysis and interpretation of multi-layer urban data. By employing a comprehensive GIS framework, the study identified the extent of integration with pre-existing urban infrastructure, with a particular focus placed on multi-layered urban areas. The analysis further delineated the integration issues and respective integration levels across historical periods, emphasizing the unique characteristics of each period. The evaluations conducted indicate that the integration of Ankara's cultural heritage sites with the city's contemporary landscape is

inadequate. This finding suggests a lack of comprehensive integration between the historical depth of the city and its current inhabitants. In light of the prevailing circumstances, the absence of spatial data concerning historical stratification underscores a notable deficit of awareness among the inhabitants regarding this multi-layered nature of the city. The physical accessibility and functionality of cultural heritage sites are crucial for their integration into the contemporary city. However, it has been found that most cultural heritage sites are disconnected from the city and most of its inhabitants due to restrictions in their accessibility or the fact that their functions cover only a limited part of the urban population. Furthermore, the visibility and perceptibility of cultural heritage sites are also important for visual integration. The presence of elements that hinder visibility contributes to the isolation of heritage sites from the urban fabric, hindering their protection and visibility. The majority of identity areas belonging to various historical periods are confronted with the aforementioned challenges concerning integration, thereby posing a threat to the sustainability of cultural heritage.

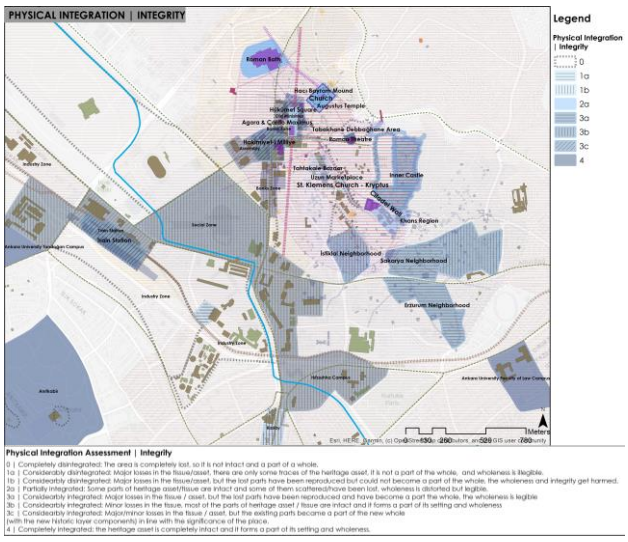

Figure 13. Physical Integration Assessment based on integrity

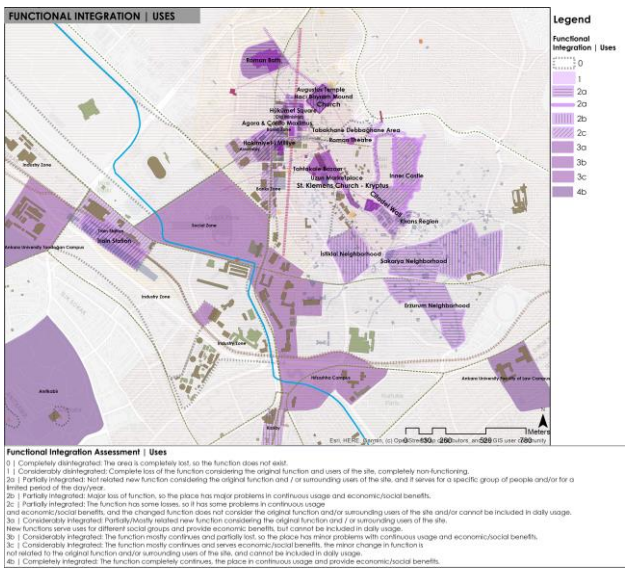

Figure 14. Functional Integration Assessment based on uses

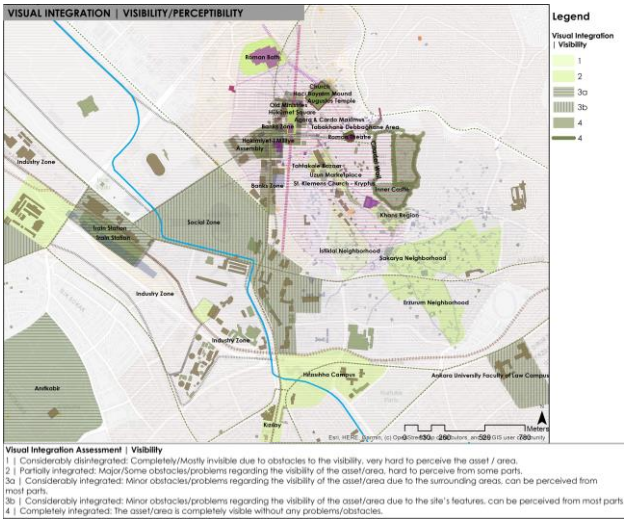

Figure 15. Visual Integration Assessment based on visibility

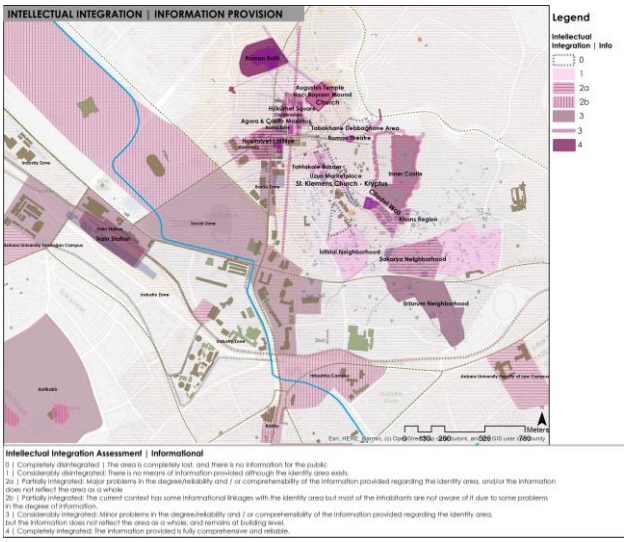

Figure 16. Intellectual Integration Assessment based on information provision

MULAAN▪GIS highlights the potential for a decision support tool that can inform conservation efforts and urban planning. It brings together data from various historical periods, structuring it in a way that allows for a comprehensive understanding of the city’s historical depth and its current urban challenges. This system can serve as a critical resource for decision-makers, offering insights into the preservation and integration of cultural heritage sites within the modern city.

4. DISCUSSIONS AND CONCLUSION

The objective of this study is to utilize Geographic Information System (GIS) technology to map the spatial traces of Ankara's historical periods. This approach involves the analysis of various data sources, including excavation records, historical and contemporary written documents, visual records, archival documents, and field observations. The analysis is conducted with the aim of understanding the spatial patterns and characteristics of each historical period, thereby providing a comprehensive understanding of the urban development of the city. Furthermore, this historical analysis encompassed an

evaluation of all historical periods, facilitating the identification of the city's stratification and the identification of areas with particularly notable stratification. Conducting more in-depth studies in these areas has revealed where there are continuities, where there are disappearances, and what is perceived or not perceived today, for each period specifically. Furthermore, the spatial organization of each historical period was revealed through the analysis of its spatial traces processed into the Geographic Information System (GIS) environment. The extent to which these areas were integrated with the existing city and its inhabitants was evaluated according to the following headings: physical, functional, visual, and intellectual integration. The results of this evaluation were entered into the database. These analyses represent the initial phase of a comprehensive system designed to guide decision-makers in planning for the future of the city and implementing conservation projects. Additionally, these analyses can be utilized by citizens to enhance their understanding of the city in which they reside.

This system is characterized by its flexibility, having been constructed using all available data from a designated period. A notable feature of this system is its capacity for modification as new data becomes available or as alterations arise. This feature enables the system to be continually accessed and updated, ensuring its relevance and effectiveness in a dynamic environment. However, for this system to evolve into a decision support mechanism, both the decision makers and the systems capable of continuously updating this data must be equipped with the necessary skills.

In conclusion, **MULAAN▪GIS,** the GIS platform developed through this research provides an essential tool for managing the complex heritage layers of multi-layered cities like Ankara. By revealing the integration levels of different historical periods with the present urban fabric, it offers valuable insights into the conservation and sustainable management of cultural heritage. This system does not only support urban decision-making but also raises public awareness, encouraging greater citizen involvement in the preservation process.

References

Alanyalı Aral, E. (2017). Ankara kentinde frig dönemi izleri: Frig tümülüsleri üzerine bir araştırma. *TÜBA-KED. 15*, 21-43. https://doi.org./10.22520/tubaked.2017.15.002

Aydın, S., Emiroğlu, K., Türkoğlu, Ö. & Özsoy, E. D. (2005). *Küçük Asya’nın bin yüzü: Ankara*. Dost Kitabevi Yayınları. Ankara.

Ayhan Koçyiğit, E. S. (2018). *A tale of Ulus square: a critical assessment of continuity, transformation and change in a historic public open space in Ankara.* Unpublished PhD Thesis, Graduate School of Natural and Applied Sciences, Program in Conservation of Cultural Heritage in Architecture, Middle East Technical University, Ankara.

Bilgin A. G. (1996). *Urban archaeology: As the basis for the studies on the future of the town case study: Bergama.* Unpublished Master’s Thesis, Graduate School of Natural and Applied Sciences, Department of Architecture- Restoration, Middle East Technical University, Ankara.

Bilgin Altınöz, A. G. (2002). *Assessment of historical stratification in multilayered towns as a support for conservation decision-making process; A geographic information systems (GIS) based approach case study: Bergama.* Unpublished PhD Dissertation, Graduate School of Natural and Applied Sciences, Department of Architecture-Restoration, Middle East Technical University, Ankara.

Bilgin Altınöz, A. G. (2003). ‘Utilizing GIS for the Assessment of Historical Stratification in Bergama (Pergamon) as a Support for Conservation Decision-Making Process’, in M. O. Altan (ed.), Proceedings of the XIXth International Symposium, CIPA 2003: New Perspectives to Save the Cultural Heritage, Antalya (Turkey), 30 September-04 October 2003, The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences Volume XXXIV, Part 5/C15, İstanbul: CIPA - The ICOMOS/ISPRS Committee for Documentation of Cultural Heritage, 650-655.

Bilgin Altınöz, A. G. (2014). Stratification: Time, Space and Memory, in Studio Log: Arch 401-402 Architectural Design Studio [2012-2013]. Fall // Fragmented Urbanism – Spring // DOHA Exploring Artistic Landscapes (Der: A. Savaş, A. van der Meij, S. Türkay, M. P. Uz), Ankara: ODTÜ Mimarlık Fakültesi Yayınları, 29-33

Bilgin Altınöz, A. G. (2021). Çok katmanlı kentteki tarihsel katmanlaşmayı çözümlemek: kent arkeolojisi. In A. U. Peker & N. Ş. Güçhan (Eds), Topluma adanmış bir yaşam... Prof. Dr. Ömür Bakırer armağanı (1st ed., pp. 107-123). ODTÜ Basım İşliği.

Çavdar Sert, S. (2017b). Bir Fikir Mirası Olarak Atatürk Orman Çiftliği’nin Somut ve Somut Olmayan Değerleri. *Ankara Araştırmaları Dergisi,* 5(2), 225-256.

Eren, Ş. G. (2023). Multi-layered Cities. In: Ş. G. Eren & A. Uluç Keçik (Eds.). *Architectural sciences and studies on historical stratifications and multilayered cities.* (Chapter 1, 1-56). ISBN: 978-625-367-443-4. IKSAD Publications.

Kadıoğlu, M., Görkay K. & Mitchell S. (2011). *Roma Döneminde Ankyra.* Yapı Kredi Yayınları.

Mıhçıoğlu Bilgi, E. (2010). *The physical evolution of the historic city of Ankara between 1839 and 1944: A morphological analysis.* Unpublished PhD. Thesis, Graduate School of Natural and Applied Sciences, Faculty of Architecture, Middle East Technical University, Ankara.

Öztürk, M. (2019). *Principles for conservation of an industrial heritage place: Ankara Sugar Factory campus in Etimesgut.* Unpublished Master’s Thesis, Graduate School of Natural and Applied Sciences, Program in Conservation of Cultural Heritage, Middle East Technical University, Ankara.

Üstün, Z. B. (2024). *Assessing the Integrity of the Historic Layers of a Multi-layered Settlement to the Current Urban Context: The Case of Ankara.* Unpublished Master’s Thesis, Graduate School of Natural and Applied Sciences, Department of Architecture- Conservation of Cultural Heritage, Middle East Technical University, Ankara.

Zancheti, S. M. & Jokilehto, J. (1997). Values and urban conservation planning: Some reflections on principles and definitions. *Journal of Architectural Conservation,* 3(1), 37-51. https://doi.org/10.1080/13556207.1997.10785179