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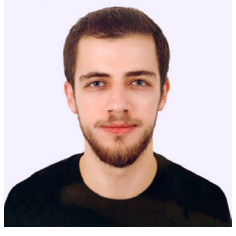

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A Methodological Approach to Redefining Spatial Relations as a Result of Archaeological Excavations: Dara

Spatial relationships play a fundamental role in the emergence, development, and transformation of cities. Especially in the context of ancient cities, the relation and spatial hierarchy between the locations of spaces such as necropolis, agora, forum, acropolis and living spaces reveal the functional distinction of spaces. Some ancient cities were discovered as a result of excavations in rural or isolated areas far from settlements, while others were found just below or within actively inhabited residential areas.
The ancient city of Dara-Anastasiopolis, one of the most significant settlements in Mesopotamia, is an interesting study area for analysing and explaining these relationships. This study aims to examine the transformation of the spatial relationships between the ancient city of Dara and the present rural settlement before and after the excavations.
The study consists of a five-stage process involving a systematic literature review, fieldwork, data generation, modelling, space syntax analysis, and evaluation. The findings reveal that spatial relations transformed significantly after the excavations uncovered the ancient city. After the excavations, a new relational network emerged with the exposed spaces, and it has been determined that this new situation affects pedestrian and vehicle circulation.
As a result, the study provides a unique contribution to the literature by providing a basis for the digital representation and management of cultural heritage sites in rural areas and analysing spatial relationships with data-based and interdisciplinary methods.

Keywords:
Dara, Space syntax, Spatial relation, Ancient city, Archaeological excavation

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INTRODUCTION

The physical and social formation of cities is based on the existence of spatial relationships. Spatial relationships directly affect the organisation of the physical environment and social functioning. The formal and functional configuration of an urban space determines users' movement practices, interaction patterns, and social dynamics (Hillier & Hanson, 1984). Spatial configuration, evaluated particularly through the concepts of directionality, accessibility, centrality, and boundaries, offers an approach that directly affects the interpretability and experience of urban space (Hillier et al., 1984; Kubat, 2015; Günaydın & Selçek, 2024).

Ancient cities offer great potential for analysing the spatial patterns of ancient societies. These settlements, located in different geographical contexts, were partially or completely destroyed over time as a result of natural disasters, wars or socioeconomic transformations. Spatial configurations revealed through archaeological excavations provide important insights into the formation of these cities. Some ancient cities are discovered as a result of excavations conducted in rural or isolated areas far from settlements. Others were found immediately below or within active settlement areas (Mayne et al., 2001; Smith, 2014; Paris et al., 2023). Ancient cities in rural areas generally present a more holistic and undisturbed plan scheme, while cities located beneath residential areas reveal a layered settlement pattern. This pattern indicates a hybrid morphology that combines past and present spatial configurations (Bintliff, 2012; Hanson & Ortman, 2017; Yesil et al., 2024).

Space syntax analysis enables the reinterpretation of historical sites by quantitatively revealing the relational patterns, guiding axes, and accessibility levels in archaeological settlements (Stöger, 2015; Van Nes & Yamu, 2021; Battistin, 2021; Askarizad et al., 2024). The theoretical framework of the analysis model explores the relationships between human, form, function, and space concepts in the real world. (Hillier, 1993; Kubat, 2015; Kamelnia et al., 2024). Space syntax analyses carried out in significant ancient cities such as Pompeii, Ostia, and Timgad have revealed the level of integration between the public spaces, trade routes, and religious buildings of these cities, thereby explaining how social organisation is reflected in space (Dobbins & Foss, 2007; Laurence, 2010; Fredrick & Vennarucci, 2020). Space syntax not only reveals the complex spatial order of ancient cities within settlements but also investigates the active role of the ways in which social interaction is organised.

Mesopotamia has both a rural texture and archaeological depth with its historical layers. This region is a geography where numerous local settlements formed by great civilisations, such as Sumer, Babylon, Assyria, Rome, and the Ottoman Empire, have developed in connection with each other throughout history (Biner, 2007; Kutlu et al., 2022). Spatial analyses of the region's settlements have the potential to provide insight not only into a single city but also into broader historical contexts (Algaze, 2009; Wilkinson, 2003). The ancient city of Dara-Anastasiopolis, one of Mesopotamia's settlements, served as an important administrative and commercial centre in the region. This study aims to identify the changing spatial patterns of the ancient city of Dara, where archaeological excavations are ongoing and where it is also used as a rural settlement area today. In the literature, space syntax studies are often based on the analysis of a static time period of an area. In this context, the study offers a unique contribution to the literature by addressing the temporal change in spatial configurations. The study develops an innovative perspective that distinguishes itself from existing archaeological space analyses.

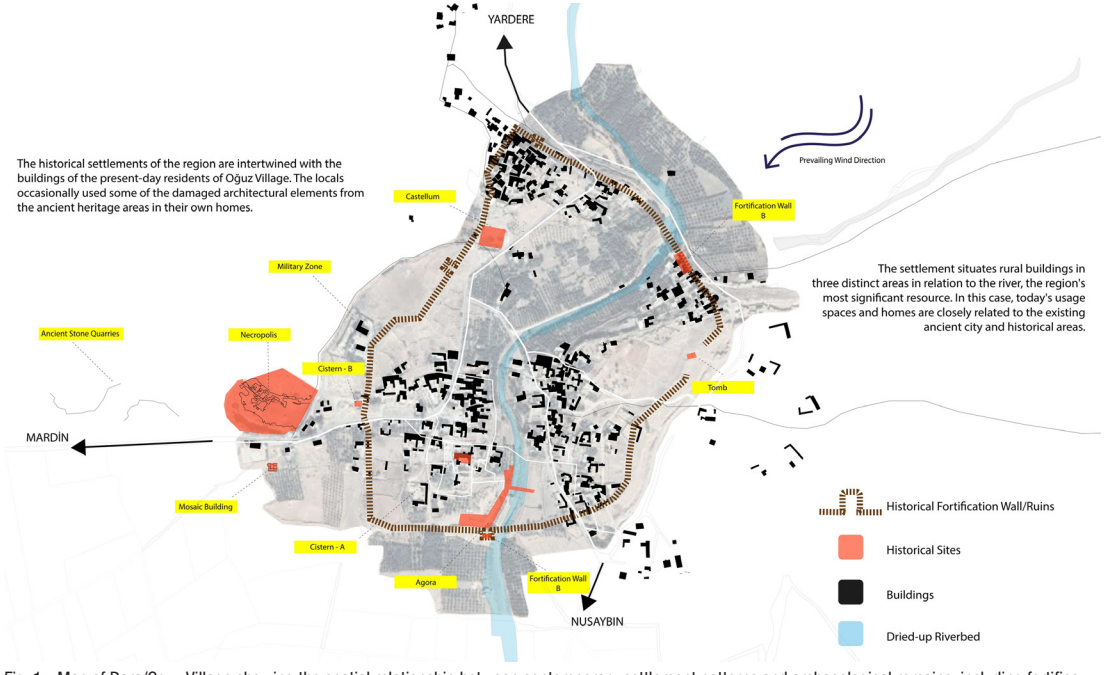

Fig. 1 - Map of Dara/Oguz Village showing the spatial relationship between contemporary settlement patterns and archaeological remains, including fortification walls, historical buildings, necropolis areas, cisterns, quarries, and other significant heritage sites (Created by the authors and Architect Rumet Alp.)

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MATERIAL AND METHOD

Dara, located in the vicinity of the Syrian border within the boundaries of Oguz Village in the province of Mardin, Turkey, was established as a military and administrative garrison city in the 6th century AD (Croke & Crow, 1983; Dursun, 2024). This city served as the administrative and commercial centre of Mesopotamia for many years (Nicholson, 1985; Kütük, 2016). From its inception, it presented an organised settlement pattern with a wide variety of functional components, from water management systems to fortified walls, religious monuments, and necropolises (Keser Kayaalp & Erdogan, 2017). With its strategic location and advanced infrastructure, it was one of the most significant cities at the eastern most edge of the Eastern Roman Empire.

The natural topography and water resources strongly influenced the settlement texture of the ancient city of Dara (Fig. 1). This urban layout, centred around the riverbed running through the city, reflects the sophistication of its water management systems and the city's understanding of sustainability. Functional components, such as cisterns (Cisterns A and B), the necropolis area, the agora, and mosaic structures, in particular, reflect the planned urban organisation of the ancient period. Figure 1 illustrates how the modern settlement of Oguz Village is intertwined with the ancient city ruins. The fact that the local population has used some of the ruined architectural elements in their own homes is a concrete example of this historical continuity. Furthermore, the fortification walls marked on the map reveal that Dara was one of the strongest defensive lines at the easternmost edge of the Eastern Roman Empire.

Archaeological excavations conducted since 1988 have rediscovered Dara, which still exists within a rural settlement landscape today. Systematic studies, particularly after the 2000s, shed more light on the city's unique morphology. As a result of surface surveys and excavations, the following sites were uncovered: "Necropolis, Fortification Walls, Gates, Agora, Castellum, Cisterns, Mosaics, and Islamic Period Tombs" (Fig. 2). As archaeological excavations progressed, transformations began to emerge in both the internal spatial organisation of the ancient city and its relationship with contemporary rural settlements. This process of transformation indicates the need to evaluate the spatial configuration of Dara using effective analytical techniques. The study examines the spatial configuration of the ancient city fabric uncovered by

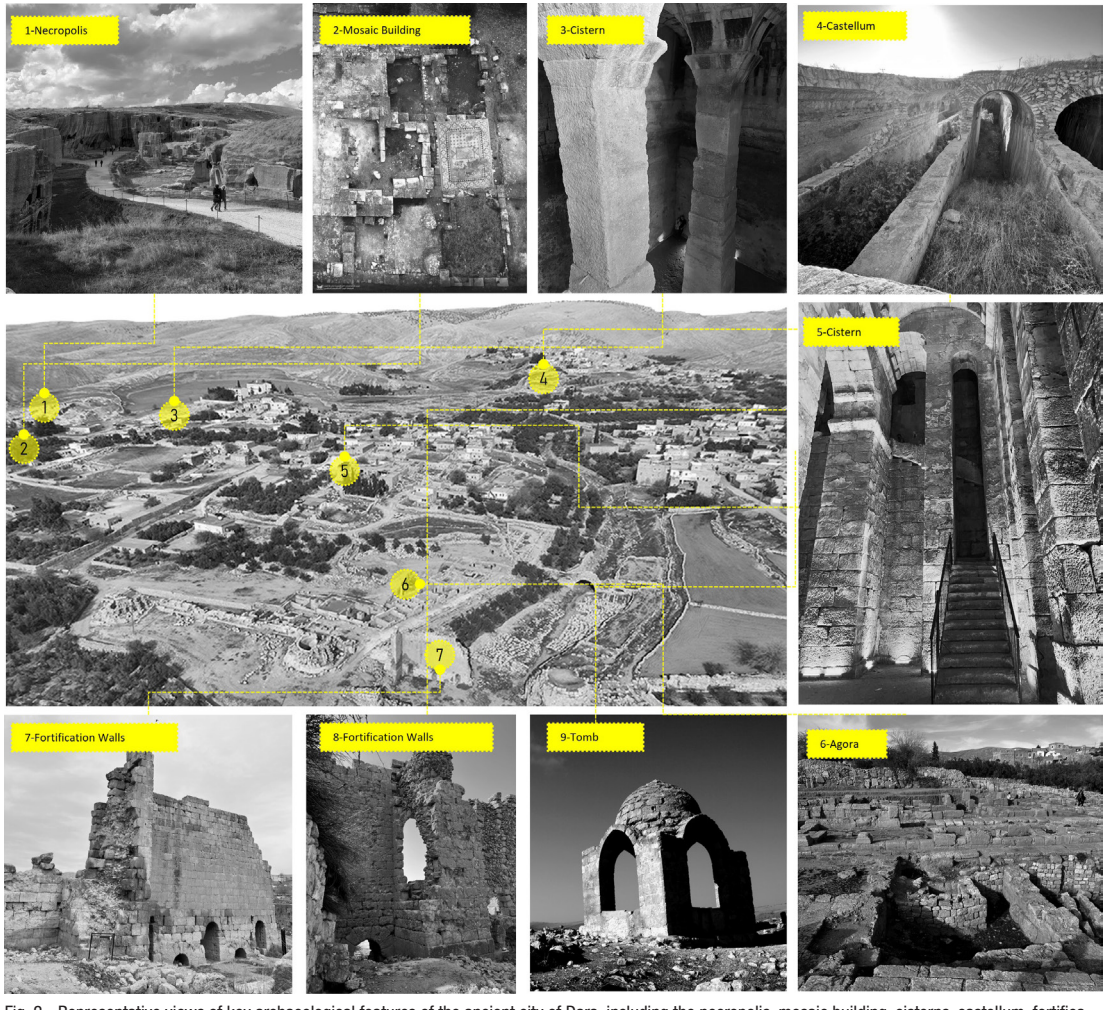

Fig. 2 - Representative views of key archaeological features of the ancient city of Dara, including the necropolis, mosaic building, cisterns, castellum, fortification walls, tomb structures, and the agora (Created by authors; the aerial -in the middle- and mosaics -top- images are sourced from Anadolu Agency.)

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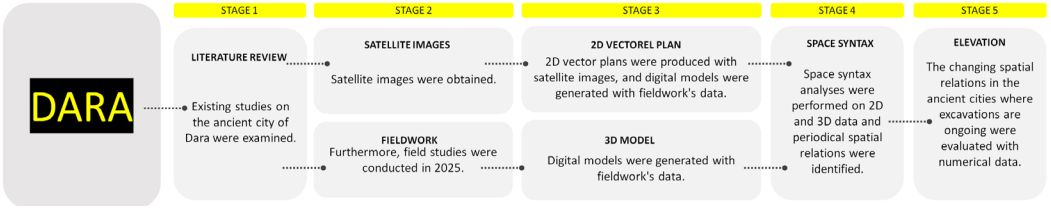

Fig. 3 - Overview of the five-stage research process applied in the study (Created by authors.)

archaeological excavations in Dara.

The study consists of a five-stage methodological process (Fig. 3). In the first stage, historical, archaeological and spatial data related to the ancient city of Dara were systematically reviewed, and a conceptual framework was established regarding the transformation of spatial relationships. In the second stage, high-resolution raster data for the region were obtained, and visual-metric data were collected through fieldwork. In the third stage, two-dimensional (2D) vector plans were produced based on the data obtained, and three-dimensional (3D) digital models were generated using the data collected in the fieldwork. Photogrammetric modelling techniques were used for the 3D models via a depth perception algorithm (Bekar & Kutlu, 2024). In the fourth stage, space syntax analyses were performed on the vector drawings using the DepthMapX software, and the data was visualised on the 3D models. Space syntax analysis was used to calculate the guiding axes, integration, selection, and accessibility metric values of the area over the years. In the final stage, these quantitative results were interpreted to evaluate the transformations in spatial relationships that emerged after the excavation. The process was designed to address not only the historical spatial configuration of the ancient city of Dara but also its dynamic spatial relationship with the current rural settlement in a multi-layered approach.

THE CHRONOLOGICAL TRANSFORMATION OF DARA

Analyses of Dara's spatial configuration revealed changes when using high-resolution raster images from 2004, 2010, 2019, and 2025 (Fig. 4).

Agricultural fields and rural dwellings largely surrounded the ancient city in 2004. Only traces of the fortification walls, tombs and castellum of the ancient city could be identified in the area, which appeared to be predominantly a rural settlement. Excavations conducted up to 2010 have clearly identified the traces of the fortification walls, mosaics, tombs, castellum, and necropolis area. However, by 2019, cistern (A) became spatially visible in areas where excavations were intensified. With the increased excavation work, the visibility of the archaeological remains on the surface also increased during this period. By 2025, the boundaries of the Agora area discovered as a result of the excavations became clearly defined, and the cistern (B) near the necropolis was also uncovered, revealing the city's public spaces and related areas.

A temporal comparison reveals that the archaeological excavations that have been ongoing in Dara for 15 years also had a transformative effect on the spatial use of the area. With the excavation of the Necropolis area in the west and the Agora in the south, a process of spatial redefinition has begun in the central axis of Dara. In particular, the fortification walls, gates, towers and mills located around the agora reveal that the entrance to the ancient city and primary transportation axes were located in this area. Additionally, it provides evidence that the southern part of the ancient city

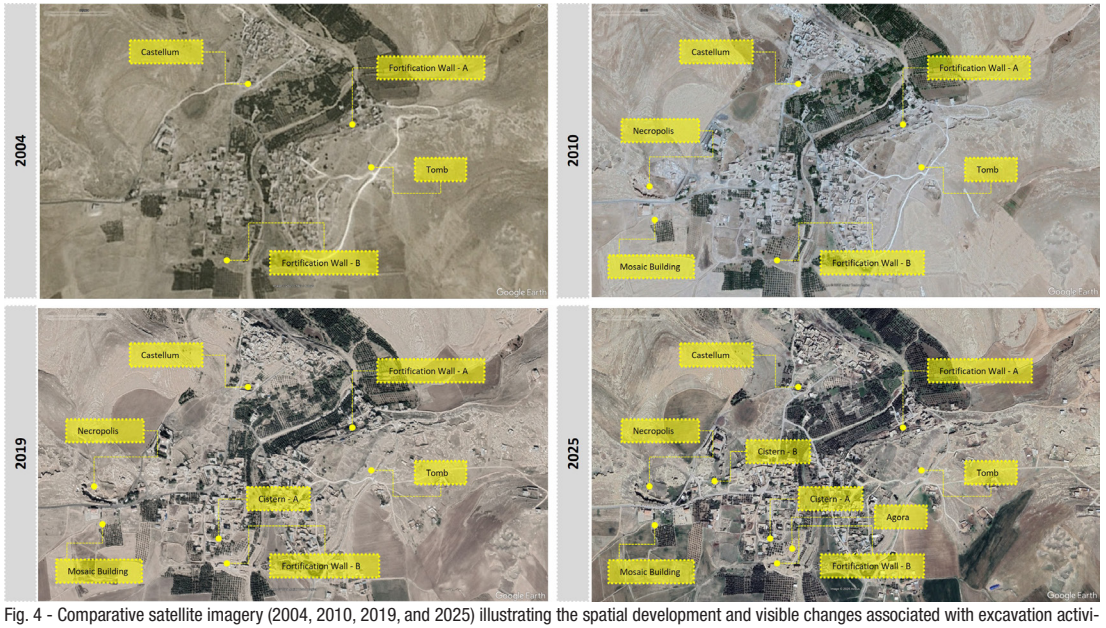

Fig. 4 - Comparative satellite imagery (2004, 2010, 2019, and 2025) illustrating the spatial development and visible changes associated with excavation activities in Dara (Created by authors using Google Earth.)

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had a commercial organisation. The castellum and cisterns discovered in the area after 2010 have given researchers information about the hydraulic infrastructure and water circulation network that distributed water from the north to the entire city.

DIGITAL MODELS OF ARCHAEOLOGICAL SITES

The study generated a digital model of the heritage buildings in Dara during the spatial data production and documentation process. During the fieldwork, historical buildings were documented in detail using both terrestrial and aerial (drone-supported) images. The Structure from Motion (sfm) method was used in the process, and the current state of the ancient city's buildings was modelled with high accuracy. Agisoft Metashape software was used in the digital modelling process, and detailed 3D models were created using the point cloud, meshes and texture maps obtained through this software (Fig. 5).
The modelling and documentation process provides data for the digitisation of relationships established with topography in new exploration processes and for real-time damage detection, along with the digital archiving of the current status of buildings. The photogrammetric model created provides a measurable and analysable dataset that enables the preparation of metric restitution documents for the area and the execution of spatial analyses. Especially in complex spatial conditions, such as irregular topography, organic settlement configurations, and undefined boundaries between buildings in ancient cities, detailed modelling techniques can offer a multi-layered and holistic reading beyond traditional drawing methods.

SPATIAL CONFIGURATION CHANGES RESULTING FROM ARCHAELOGICAL EXCAVATIONS

It is critical to conduct space syntax analyses within a time series to evaluate the impact of archaeological excavations on urban morphology.

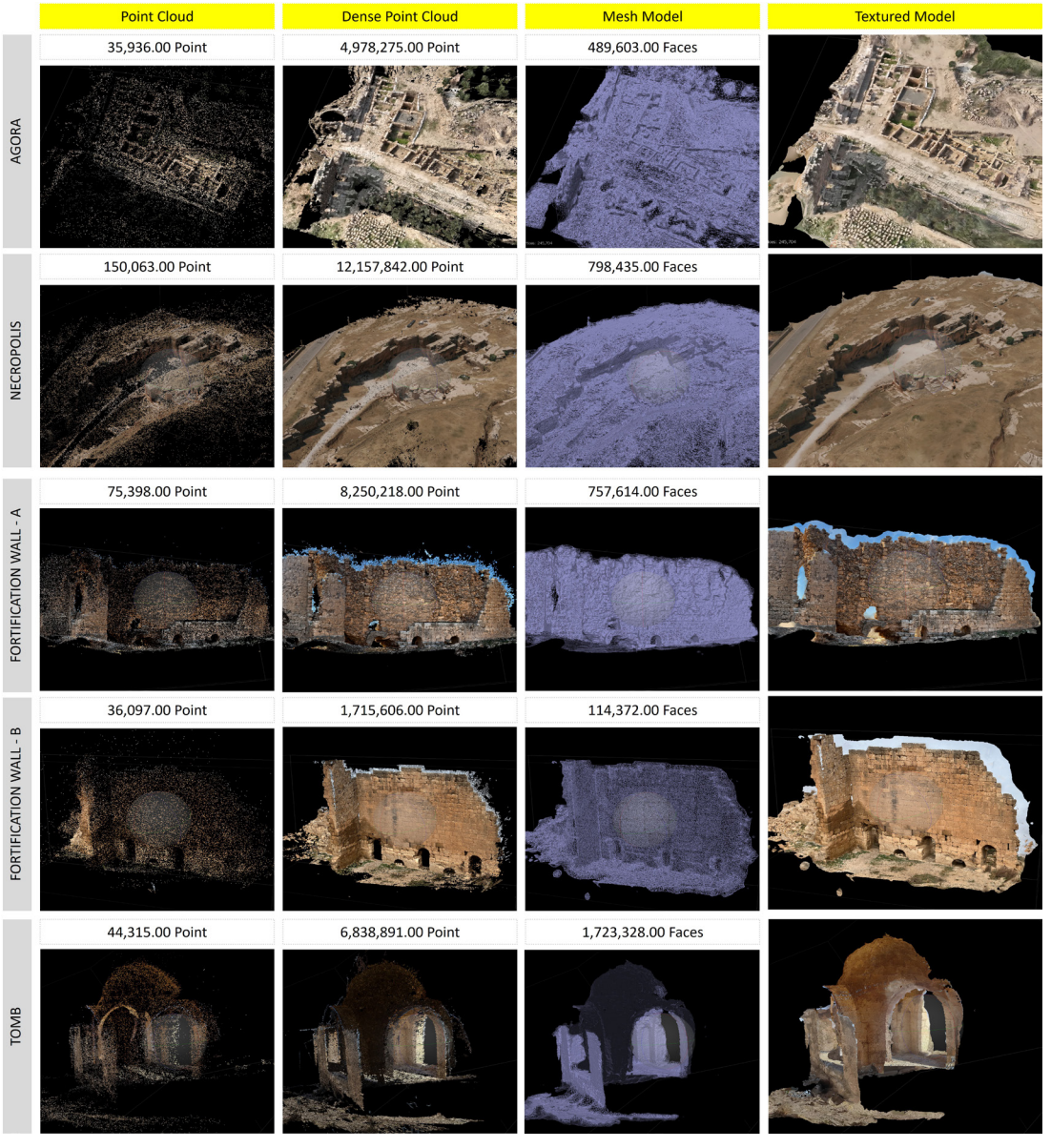

Fig. 5 - Stages of 3D modeling for agora, necropolis, fortification walls A and B, and tomb archaeological features of Dara (Created by authors.)

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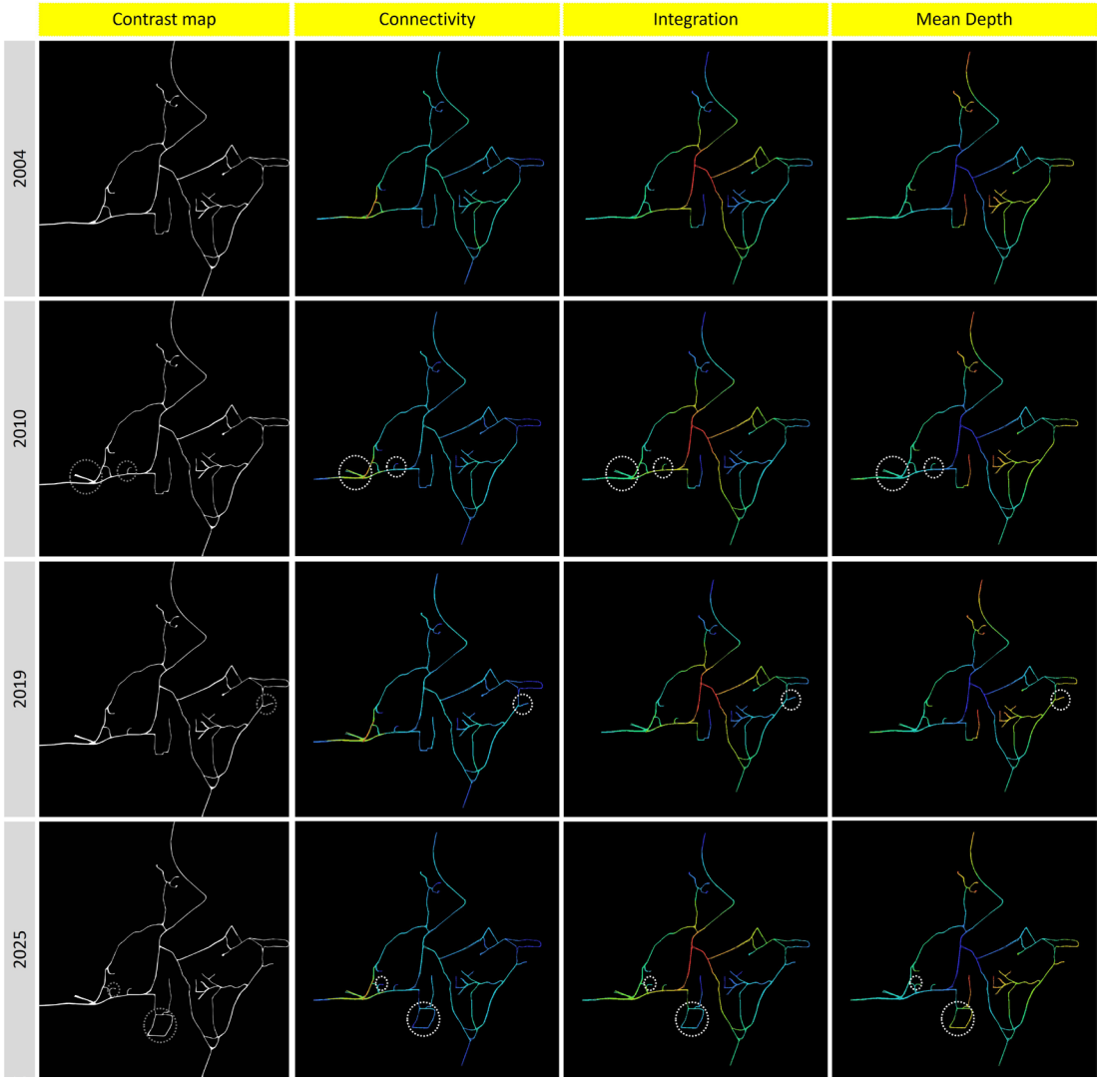

Fig. 6 - Space syntax analysis maps of Dara across four time periods (2004, 2010, 2019, and 2025). For each year, contrast maps, connectivity, integration, and mean depth values were visualized. Together, these maps revealed shifts in spatial structure, highlighting changes in centrality, accessibility, and hierarchical depth within the settlement as excavation and documentation progressed (Created by authors.)

This is because understanding the transformation of space and the reorganisation of social relations is only possible through a temporal analysis. In the analyses conducted at Dara, raster images from 2004, 2010, 2019 and 2025 were converted into a vector format to create a dataset that would enable the comparison of spatial configurations. These vector data sets were integrated into the DepthMapX (v.0.8.0) software, and axial map analyses were conducted separately for each year. The analysis focused on connectivity, integration, and mean depth metrics. These three metrics, along with the geometric density of the guiding axes, provide a comprehensive view of the functional centres, access potential, and depth of the spatial system.

Connectivity defines local connectivity in the network structure by determining the number of other axes that each axis directly contacts. It is particularly useful in defining public spaces and transition points in rural settlements. Integration measures the degree of centrality within the overall circulation network of the space by considering the distances between all axes within the system. This metric plays a critical role in assessing the impact of new areas uncovered by excavations on urban circulation. Finally, the mean depth metric calculates the average distance of each axis from all other axes to indicate the degree of structural density of the space. This data enables the systematic separation of sections with limited access, such as necropolises and fortification walls (Has, 2022; Ergün et al., 2022; Bekleyen, 2024). Figure 6 presents the results of the analysis conducted within the time period under consideration. Thus, the transformation of the space-time configuration can be visualised and represented using numerical data.

When the change in the area over time is examined through axial maps, a fragmented and dispersed circulation network describing the rural settlement pattern is visible. When the change in the connectivity value is examined as a result of the analyses, it is observed that it became apparent on the axis in front of the necropolis, which was not yet discovered in 2004. In 2004, the necropo-

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lis area's connectivity value was 84, but it was 106 in 2010 after the necropolis was found. With the discovery of the necropolis, the highest connectivity value in Dara is found on this axis in all years. When examining the changes in the integration value, it is noted that the axis leading to the castellum has the highest value in all years. The value, which was 1.10405 in 2004, was found to have increased to 1.12878 in 2025. When examining the changes in mean depth values, it was determined that the highest value in 2004 was 17.1381 on the cistern B axis. In 2010 and subsequent years, this value decreased to 17.1185 and changed towards the village centre axis.

The analysis for 2004 reflects a period when systematic archaeological excavations were not yet started. Connectivity analysis reveals that only a few local axes were identified this year, and the integration value indicates a low-density and dispersed circulation. In particular, the mean depth map demonstrates that the system is structurally deep and fragmented, meaning that an integrated circulation system was not formed. This pattern reflects a period in which the ancient city was largely covered, but its spatial configuration was unclear from an archaeological perspective. In 2010, limited spatial expansion in the urban form was observed due to the impact of the first phase of excavations. Connectivity reveals an increase in the number of connections along certain axes in the western part of the settlement, particularly along the main transportation axis (cestellum road), which has become partially discernible. Integration analysis shows that integration values have increased along more central settlement axes, but the overall network structure remains polycentric. The mean depth map shows a decrease in depth. This year, the newly constructed roads and the emerging archaeological areas can be interpreted as a transitional phase in which the urban movement network is beginning to change.

The 2019 excavations were a period of intense expansion, during which important archaeological structures were identified. Connectivity analysis revealed a significant improvement over previous years and a more consistent network. Integration values revealed a stronger centralisation and more distinct main pedestrian routes. In the mean depth analysis, it can be said that this period represents a time when the depth of the system was more evenly distributed and the settlement structurally began to integrate. These findings clearly reflect the direct impact of excavations on spatial organisation. The analysis for 2025 represents the period of greatest spatial change due to new discoveries in the city following excavations. In this map, connectivity metrics show high density on central axes and a more balanced access network due to increasing connection points on peripheral axes. On the integration map, the axes in the city centre have very high values, indicating that the agora, the mosaic structure, and the newly discovered areas have become important centres for urban integration. In the mean depth analysis, it is observed that the overall structure has become shallower, and new users have gained more direct access to different areas. The 2025 analysis strongly indicates that the excavations in the ancient settlement not only physically uncovered the site but also signify a transformation in the spatial network.

The analysis conducted for four different years clearly demonstrates that interventions performed in archaeological sites have reshaped the urban spatial configuration and that this transformation can be tracked numerically and visually using the space syntax method.

EVALUATION AND DISCUSSION

n today's archaeological research, the possibilities offered by digital technologies are increasing the depth of spatial analysis. Digital technologies enable spatial analysis to be interpreted in a time- and space-oriented and layered manner. The 3D photogrammetric models developed within the scope of this study have provided an infrastructure that enables the documentation of archaeological sites and the interpretation of the spatial context of space syntax analysis. In particular, point cloud and textured model productions in archaeological heritage sites have ensured that details that traditional methods may fail to capture are documented in their entirety. Thus, data related to the documentation and analysis process were produced, and a comprehensive study process was implemented. Spatial fragments created over the years through space syntax analysis show how the excavation process of the area evolved in terms of dynamic parameters such as connectivity, integration, and mean depth.

The excavations in Dara reveal that each new heritage site or circulation axis that emerges as a result of the excavations dynamically reshapes the urban morphology of the settlement. In particular, space syntax analyses have made this transformation measurable with numerical data and traceable through comparisons based on data produced over the years. In this respect, archaeological excavations contribute to the discovery and documentation of cultural heritage while also revealing the spatial harmony between the contemporary settlement pattern and historical buildings, as well as the changes that have emerged. However, the impact of such excavations is not limited to spatial and physical transformation. The spatial and social consequences of archaeological work, especially when it is integrated with settlements such as Dara where life continues, must not be disregarded. This situation has positive implications;

- Revealing historical heritage and strengthening the cultural landscape,
- Developing archaeological tourism and supporting the local economy,
- Revitalising urban memory and raising awareness of cultural identity.

However, the excavation processes in this case;

- Deformation of daily life circulation,
- Reconsideration of land use rights and public space boundaries,
- Inadequate planning may also have ne gative consequences, such as the risk of physical damage to cultural heritage.

At this point, analysing the findings in 2D limits the interpretation of the space and the relationships that constitute it. In this study, the analyses conducted were also presented in 3D (Fig. 7).

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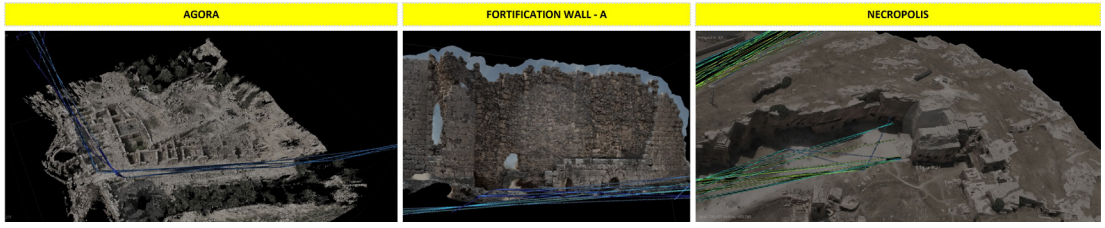

Fig. 7 - Integration of space syntax analysis with 3D digital models (Created by authors.)

Each new archaeological discovery attracts attention at the local and national levels, increasing visitor traffic and tourist-orientated spatial transformation in the region. While such change creates new economic opportunities, it can also become a challenging factor for existing rural life practices, property relations, and social dynamics. Future studies in archaeological sites should be supported by multi-layered models that include social, cultural, and geographical dimensions of spatial analysis. As in the case of Dara, the metric mapping, 3D modelling, and spatial analysis of excavation processes enables the comparison of spatial experience with numerical data in archaeological sites with high tourism potential. Additionally, these analyses provide a dataset for user experiences and site management in archaeological sites. This study also demonstrates that methods such as space syntax offer a new framework for interpretation and decision-making beyond traditional conservation strategies.

CONCLUSION

The studies conducted at archaeological sites helps connect and reinterpret a society's collective memory, social organisation, and spatial thinking system for the present day. These sites are the most important representations of tangible and intangible cultural heritage. Therefore, the preservation of archaeological landscapes, as well as making them accessible, understandable, documentable, and plannable, forms the basis of sustainable cultural heritage management. This study aims to fill an important gap in this field by analysing the ancient city of Dara, one of the most unique settlements carrying the historical continuity of Mesopotamia, through the spatial transformations it has undergone over the years. Despite the systematic excavations conducted since the 2000s, the absence of a study analysing Dara's spatial patterns over time was the main motivation for this research. Dara presents an extraordinary archaeological-urban hybrid area profile, not only due to its historical importance but also because of its unique structure integrated with the rural landscape where life continues to this day.

The 3D models obtained in the study provide high-precision digital representations of different buildings in the ancient city. These data serve as reference documents not only for today's research but also for future research. The models provide a multidisciplinary database that can be used in various disciplines such as architecture, archaeology, urban planning, and conservation. In conservation processes, the creation of measurable and comparable spatial sub-areas paves the way for scientifically based interventions. Space syntax analyses have revealed the changing spatial relationships through excavations in numerical terms. They also highlight how the existing rural lifestyle was structurally and functionally affected. This situation demonstrates that any intervention in archaeological sites is not merely physical but must also be considered in conjunction with the living communities. In this context, both space syntax data and 3D models function as academic analytical tools and interactive representation environments for decision-making institutions, conservation experts, and local stakeholders.

As a result, this study makes a unique contribution to the literature by revealing that the impact of excavations on archaeological sites is not only physical but also spatial, functional and social. Space syntax analyses and digital models integrated with time-space comparisons present a powerful methodological proposal for multi-layered, data-driven, and participatory approaches in the field of cultural heritage in the future. This has the potential to serve as an important roadmap for both academic knowledge production and sustainable heritage management at the local level.

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