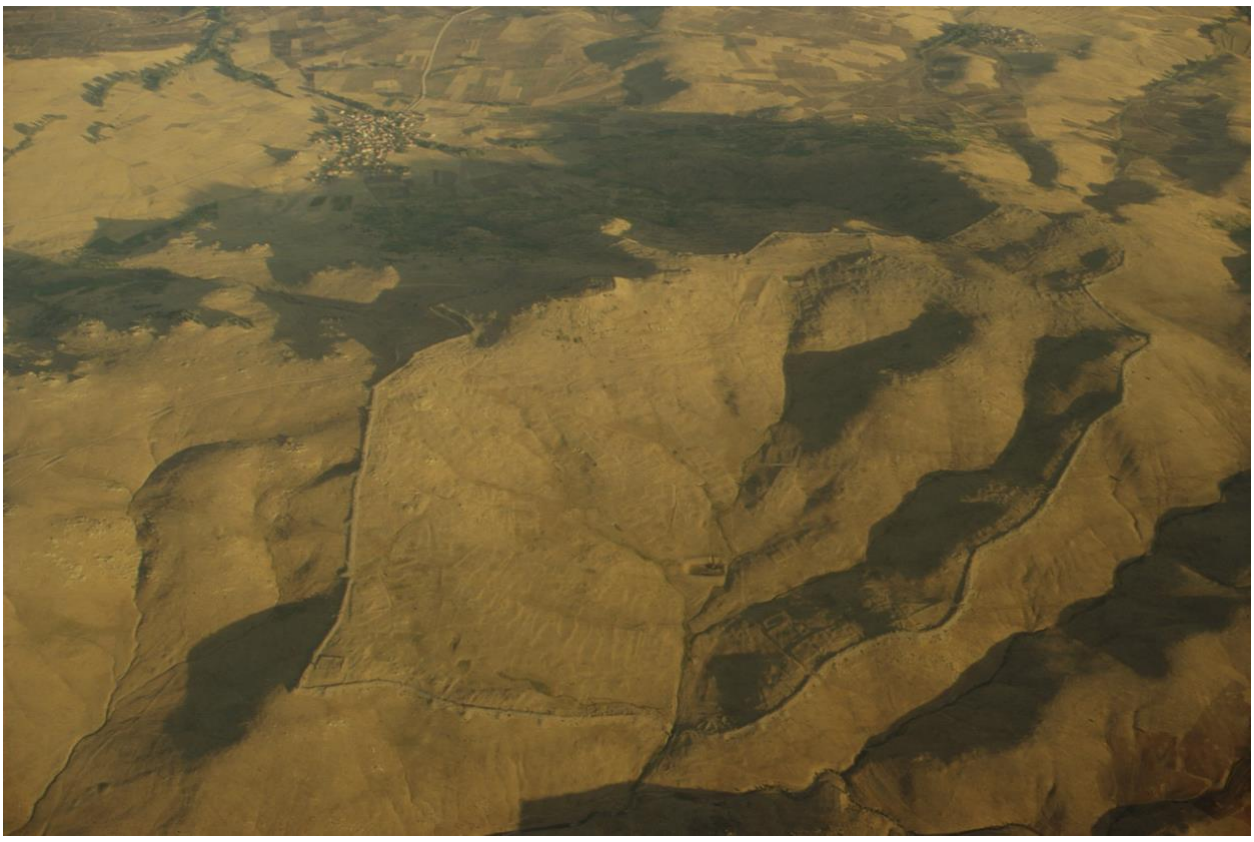

(The Kerkenes Project, n.d.)

# Analysis of Urban Compounds in the Ancient City of Kerkenes

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Dina Kazemi Beidokhti
480026127

## Abstract

This study aims to investigate the structure of urban compounds in the ancient city of Kerkenes Dag and to compare the peripherality of different areas within the city. Using the 3D and spatial analyst tools in ArcGIS Pro, the main characteristics of these compounds such as their area and elevation have been compared across the site. Additionally, the Origin-Destination Cost Matrix, part of ArcGIS Pro's network analysis toolset, has been employed to calculate the ease of travel between each city gate and the significant structures inside the city.

Categorising compounds based on their area creates clusters of similar-sized structures particularly in the southern and eastern parts of the site. Network analysis also indicates that the eastern gates are the furthest, in terms of travel cost, to the significant structures within the city.

These results have created clear distinctions between different parts of the city and could be used to provide a more detailed layout of the site. Considering the size of compounds as a social factor, the eastern side could be considered a periphery when compared to the south which includes the palatial complex and the larger compounds.

While these details could help assess the complexity of urban life at Kerkenes, it should not be the only source of information for doing so. This study could be complemented by integrating data from new sources, for example resistivity and magnetometry surveys which have been done extensively across the site.

## Introduction

The Iron Age city of Kerkenes, located in Central Turkey, was inhabited for less than 100 years during the late 7th and early 6th century B.C. (The Kerkenes Project, n.d.). Although it is certain that it was destroyed by fire, most probably due to conflicts between the Lydian and Persian empire, the origins of the city and its inhabitants are still unclear. (The Kerkenes Project, n.d.). The carefully planned urban structure of the site has been the focus of scholarly attention in the past few decades, meaning that a variety of datasets, for example from resistivity and magnetometry surveys, are available for analysis.

By using the data on city compounds and streets, this study aims to perform a comparative analysis of compound characteristics, and subsequently, the urban structure of Kerkenes in different parts. As discussed by Steadman (1996), spatial patterning analysis of

architectural remains could provide valuable information on human behaviour. Thus, this study could help illuminate some of the social aspects of life in Kerkenes, which could be a step towards determining the origins of the city and its inhabitants.

### Data

The data used in this study consists of two main parts:

1. A vector dataset which includes information about the compounds, gate locations, and streets. This dataset originally used the site's local coordinate system and therefore, needed to be georeferenced first. Information about the control points necessary for transforming the local coordinates to WGS-1984 UTM Zone 36N was also included.
2. The terrain's surface elevation information was also provided by a TIN model which was created using the GPS points collected on the field.

## Methods

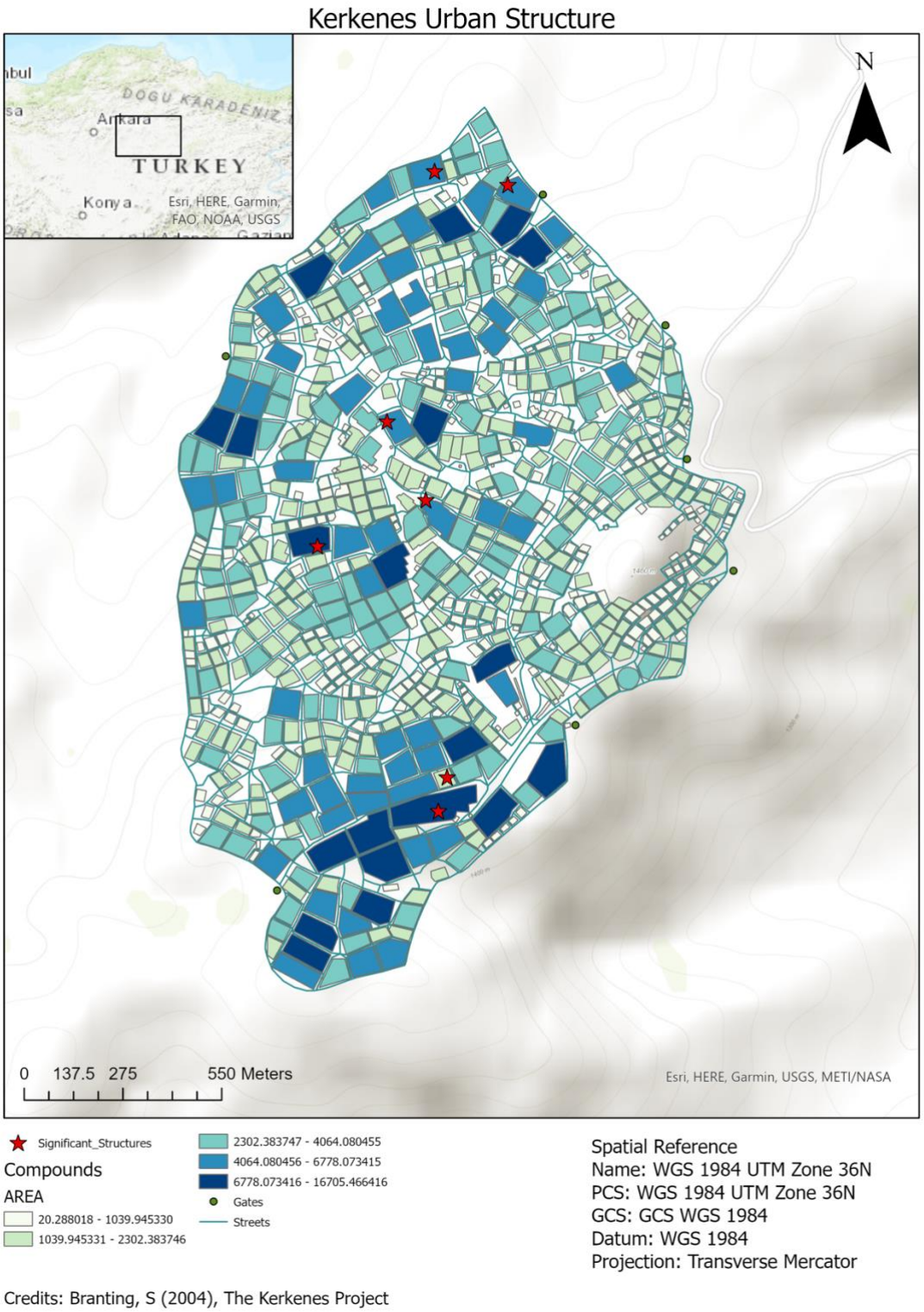
The **Spatial Adjustment tool** in ArcMap was used to georeference the vector data given that no such tools are available in ArcGIS. **Symbology** was then used to put the compounds into 5 groups based on their area value. Using the **Summary Statistics** tool, the average of compound areas was calculated and **expression builder** in symbology was then used to group compounds into two different classes (below and above average). Next, significant structures inside the city were added to the map using the **Add Feature Dataset** tool.

To add elevation and slope information, the TIN model was provided as input to the 3D analyst tool, **Add Surface Information,** which subsequently derived and added minimum, maximum, and average slope and elevation to the compound and street datasets. Next, the compounds table was extracted as an excel file with the **Table To Excel** tool, which was then used in R to create plots of area vs elevation and area vs slope for compounds.

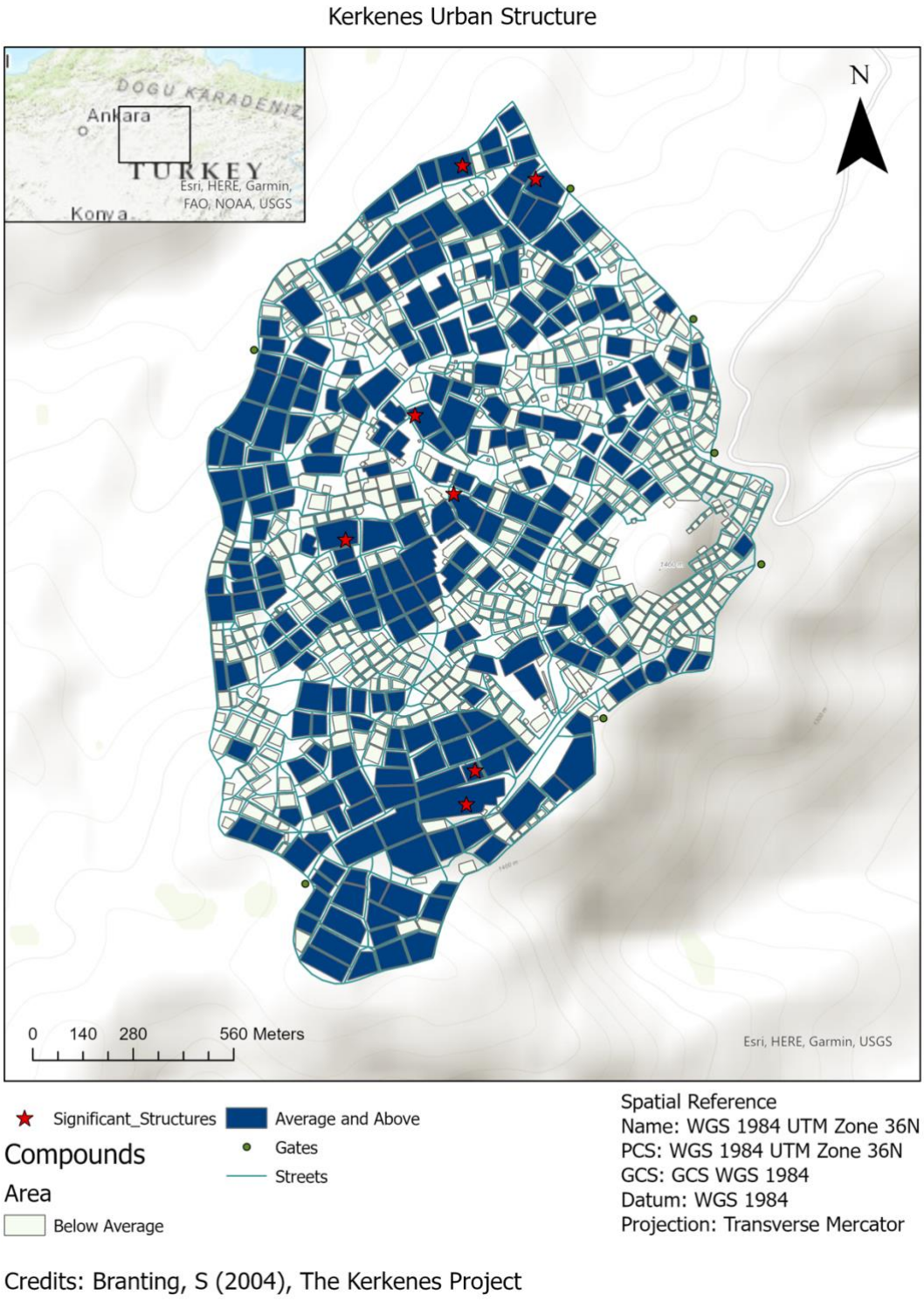
Using the **TIN To Raster** tool, the TIN model was turned into a raster, which was subsequently provided as the input layer to the **Aspect** tool to calculate the direction of slope across the site. A new field was then added to the compounds data table called Area_Cat, which assigned a category to each compound based on their area value (using the area thresholds previously defined by symbology). This was done by creating a python script for calculating the value of the field. **Zonal Histogram** was then used to create a new table to count the number of each area category with a particular slope direction. This new table was again exported as an excel file to create a bar plot of the result (see Appendix).

Finally, using **Create Network Dataset** tool, a network dataset was created using the city's streets and street length and slope were added as travel costs. The network was then built with the **Build Network** tool, which made it possible to use the network analysis toolset, including the **Origin-Destination Cost Matrix**, to determine the distance between each gate and its closest significant structure.

# Results




Map 1-Map of urban compounds classified based on their area value




Map 2-Map of urban compounds classified in two groups using average area value as the threshold

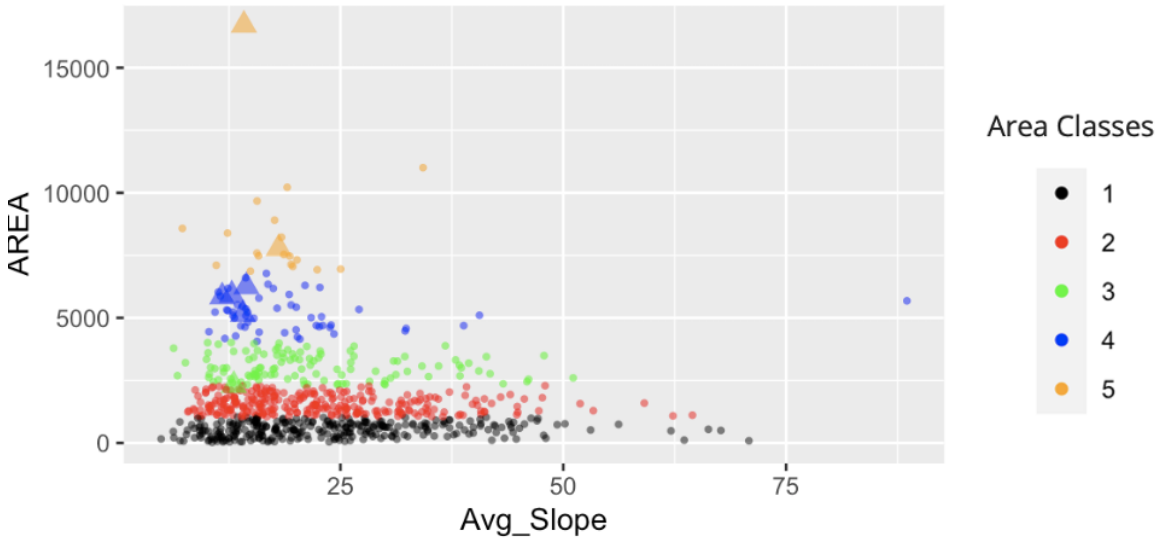



Figure 1-Area vs average slope with each point representing a single compound. Compounds are divided into 5 groups using their area based on the grouping represented in Map 1. Significant structures (refer to Map 1 and Map 2) are represented with triangles.

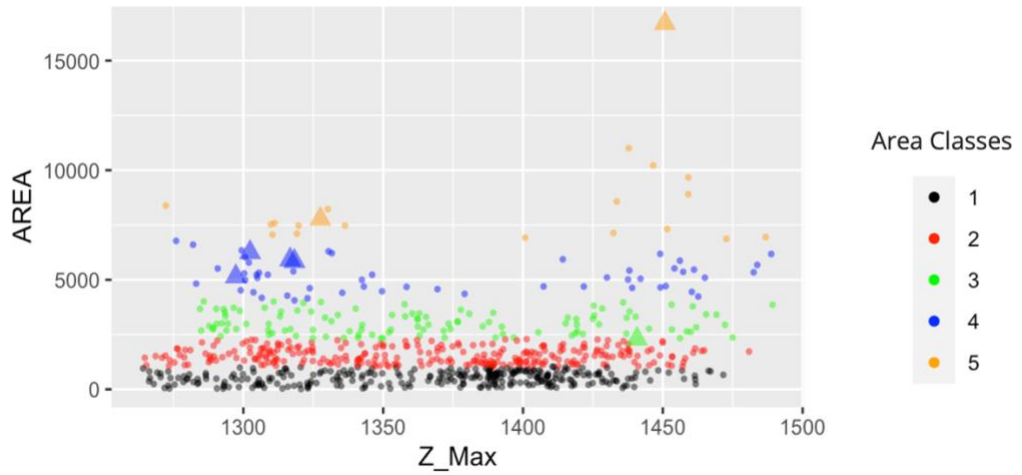
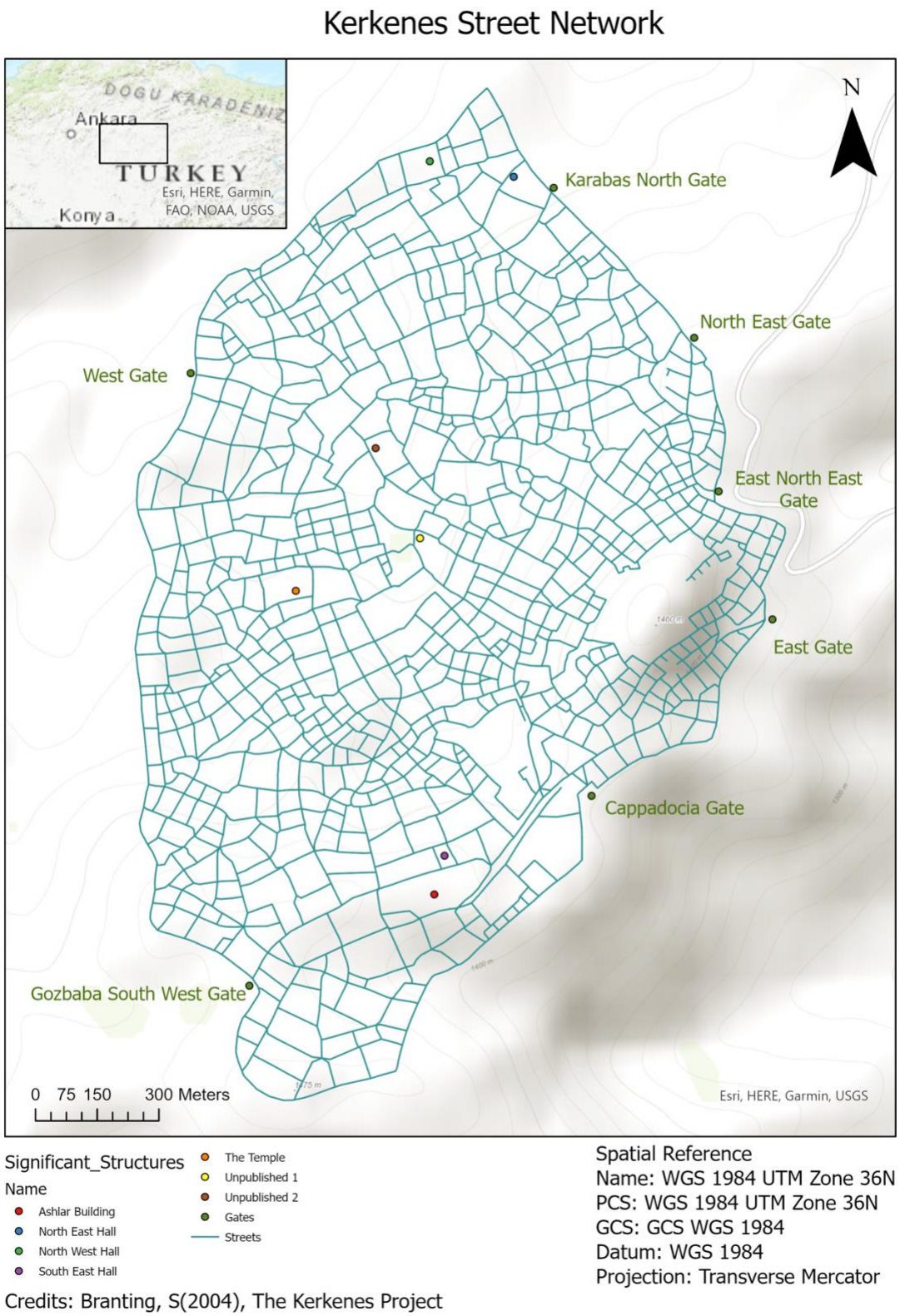



Figure 2-Area vs Maximum elevation with each point representing a single compound. Compounds are divided into 5 groups using their area based on the grouping represented in Map 1. Significant structures (refer to Map 1 and Map 2) are represented with triangles.




Map 3-Map of street network, gates, and significant structures

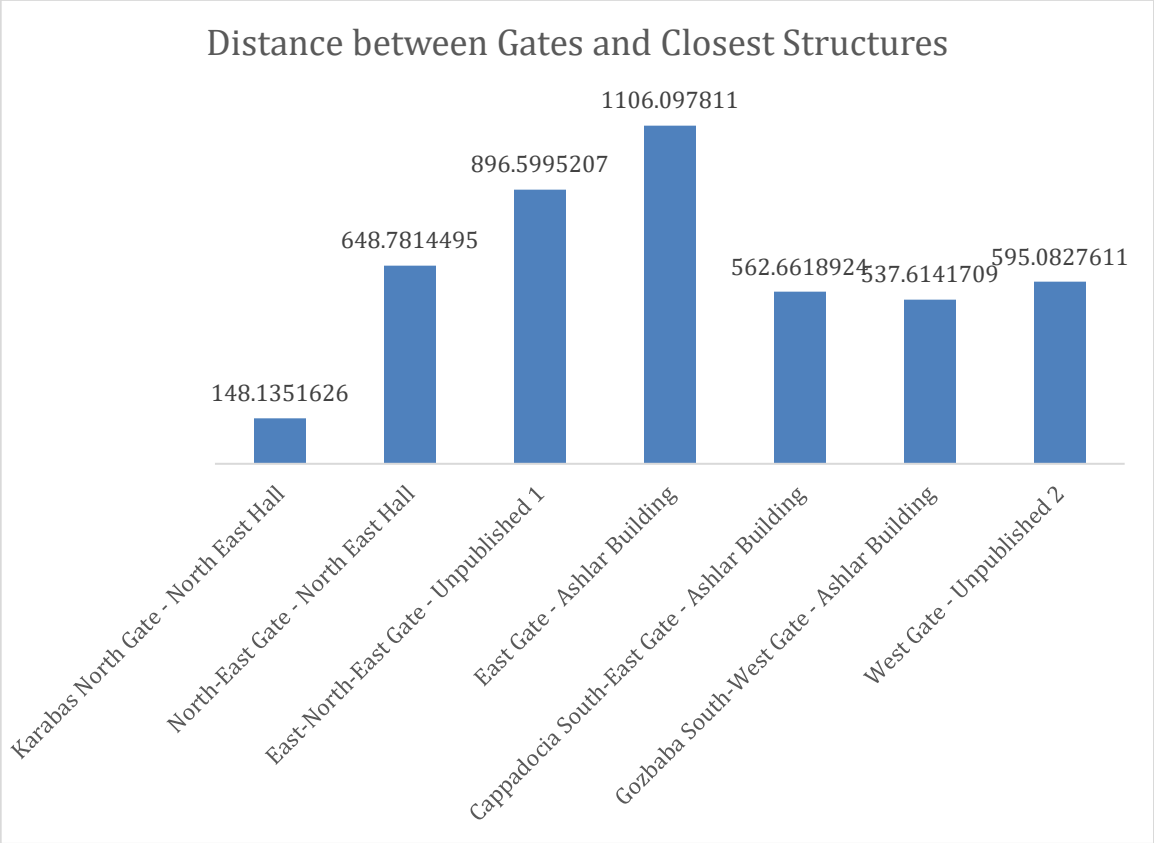



Figure 4-Distance between each gate and its closest significant structure (refer to Map 3)

## Major Findings

Maps 1 and 2 clearly indicate the different clusters of compounds after they have been grouped based on size, particularly around the eastern and southern gates. This is further supported by the fact that two significant structures (the palatial complex and south-eastern hall) are in the southern side of the city. Furthermore, Figure 4 shows the three eastern gates (North-East, East-North-East, and East) are the furthest from the more important structures across the site. It is also important to note that, as indicated in Figure 1, larger structures are in the less steep parts of the city, while smaller buildings have various slope values. There does not seem to exist a similar pattern between compound area and elevation (Figure 2).

# Discussion

These findings confirm that there is a difference in how the city was structured in the eastern parts when compared to the other areas. Given the area of the compounds in the eastern section of the city and the fact that the eastern gates are further away from the

more significant structures in terms of travel cost, one could suggest that this side of town was probably more peripheral in nature, while the southern area was the more important administrative side of the city. These findings could be significant for the research team when planning excavations across the site as they provide more insight into the, to put it into the modern terminology, different neighbourhoods. The reason behind this way of structuring the city could be sought in the political plan of the bigger region.


Map 4-Central Anatolia 7th – 10th century B.C. (Wittke 2010)

This map clearly indicates that Kerkene (marked with an arrow) was possibly under the Phrygian influence, whose important sites (such as Gordion and Bogazkoy) were located to the south, west, and north of the city. In the east, however, territories of the different competing political entities such as Urartu and Assyria were located, which given their extent and power during this period, must have been intimidating for these smaller polities. This aligns well with the fact that the eastern gates were more peripheral compared to the other gates, which could be indicative that the city builders were concerned about the security of the eastern subsection. The aforementioned fiery end of the city, which was most probably due to a political conflict, further supports our discussion and results here.

A less relevant discovery is the fact that the larger (and probably the more important) compounds were in the less steep locations, which could imply that slope had an important role in defining the more desired locations throughout the city, especially given that Kerkenes has a noticeably uneven surface area. The relationship between compound area and aspect was also analysed (Table 1 and Figure 3 in the Appendix), but no result was discovered at this stage.

This study was successful in comparing the urban structure of Kerkenes across different parts of the city and supporting the results with the political map of the bigger region. Nevertheless, since only one source of information was used (compounds), the findings are somewhat limited, as for example, they do not offer insights into the structure of the other parts, like those around the northern and western gates. Moreover, compound area was utilised as the only indicator of the level of social differentiation across the site, which again is a very limited source of information to draw on when considering the complexity of the question.

Therefore, this study would benefit from incorporating new data such as resistivity and magnetometry survey results to offer new perspectives into the matter. Other types of analysis, for example modelling where the fire that burnt the city first started could help assess the validity of our results and assumptions about the potential location of the political conflict which resulted in the fire. Hence, a future consideration in this study is to analyse the site's urban structure using the remotely sensed data by drawing on machine learning classification techniques.

## Conclusion

In conclusion, by comparing the characteristics of different urban compounds across the site of Kerkenes, this study tried to analyse the structure of the city in different parts to offer more insights into its social composition. The results generated by the various 3D and spatial tools in ArcGIS was aligned with the layout of the ancient political entities in the bigger region of central Anatolia during the Iron Age. A future objective of this study is to use the results of resistivity and magnetometry surveys to further expand the depth of the analysis.

## Acknowledgements

I thank Dr. Seppi Lehner (University of Sydney) and Dr. Scott Branting (University of Central Florida) for their support and for providing the datasets used in this study.

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# Appendix

| OBJECTID | LABEL | Area__1 | Area__2 | Area__3 | Area__4 | Area__5 |
|---|---|---|---|---|---|---|
| 1 | Flat (-1) | 0 | 0 | 0 | 0 | 0 |
| 2 | North (0 - 22.5) | 8870 | 27182 | 20691 | 24035 | 10506 |
| 3 | Northeast (22.5 - 67.5) | 22823 | 47427 | 49757 | 34995 | 27302 |
| 4 | East (67.5 - 112.5) | 15887 | 26019 | 26503 | 11062 | 17035 |
| 5 | Southeast (112.5 - 157.5) | 10168 | 21729 | 13820 | 14889 | 20956 |
| 6 | South (157.5 - 202.5) | 4421 | 11823 | 19960 | 15197 | 6521 |
| 7 | Southwest (202.5 - 247.5) | 7754 | 28990 | 24393 | 18147 | 2021 |
| 8 | West (247.5 - 292.5) | 22021 | 62921 | 45646 | 40141 | 14710 |
| 9 | Northwest (292.5 - 337.5) | 31064 | 103716 | 59107 | 59510 | 30104 |
| 10 | North (337.5 - 360) | 5721 | 27470 | 22765 | 23880 | 11160 |

Table 1-Table created by the Zonal Histogram tool. Area_1 to Area_5 represent the grouping in Map 1, with Area_1 being the smallest compounds and Area_5 the largest ones.

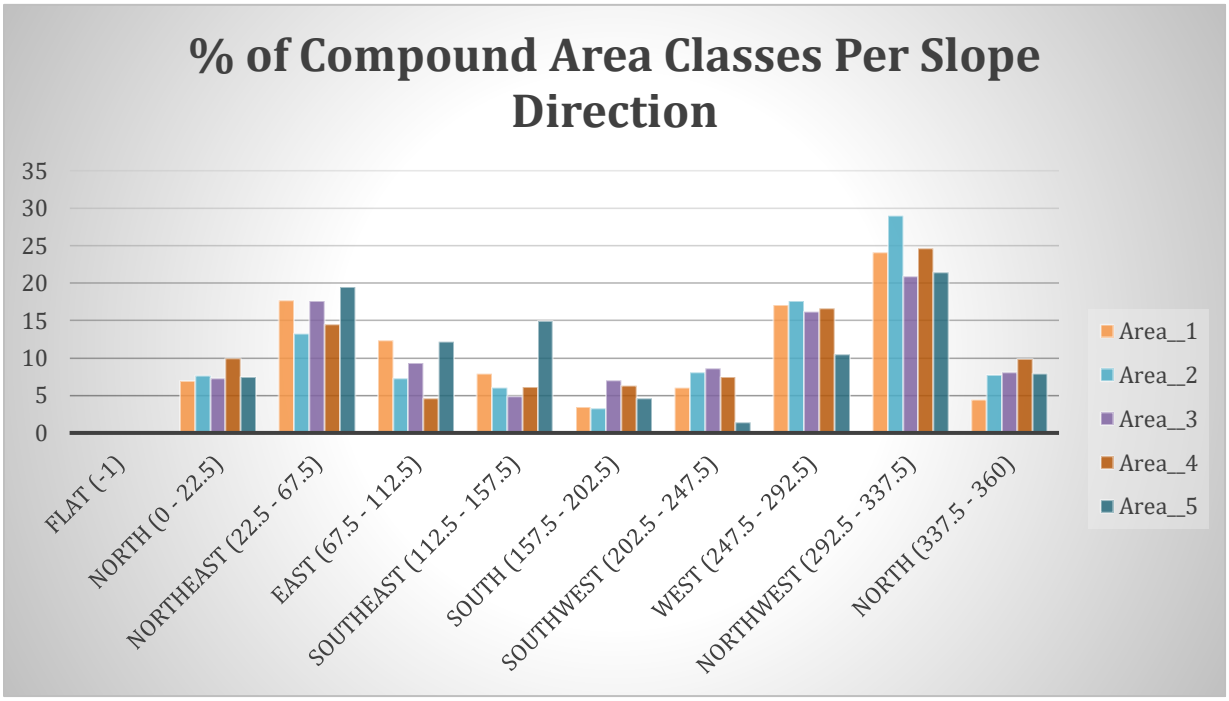


Figure 3-Percentage of compound area classes per slope direction (aspect)