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# GIS INVESTIGATION OF SITE SELECTION OF HISTORICAL STRUCTURES: THE CASE OF KNIDOS (DATÇA, TURKEY)

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## ABSTRACT

In archaeological research, the collection, storage, query and analysis of data is conducted with the help of the Geographical Information System (GIS) in order to acquire the most accurate information about the area. Spatial analyses made with the help of GIS in ancient cities contribute to revealing the social, cultural and survival features of these cities.

The aim of this study is to examine the rationale for spatial site selection in Knidos ancient city, which is in the Turkish province of Muğla and which has different city planning with its geographical features. For this reason, firstly, a digital elevation model that reveals the topography of the city was constituted. Then, the database design and spatial analyses (slope, aspect and visibility) were conducted in line with the aim of the study in ArcGIS 10.2 Software. The site selection rationale for structures was evaluated through spatial analyses (slope, aspect and visibility) in Knidos ancient city. Site selection rationales of the historical structures have been ascertained related to the preferred planning form of the period (grille planning), the geography of the city, the functions given to the historical structures, the visibility of structures, the ports which were as a focal point of the city, the ideological point of view and the reflection power of the ruler's.

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**KEYWORDS:** GIS, Site selection, Spatial analysis, Archaeology, Topography, Mapping, Knidos

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## 1. INTRODUCTION

GIS, which is used by a number of different disciplines today, has become an important application field for the science of archaeology (Xiong and Liu, 2005; Pluckhahn, 2007). Quantitatively analyzing data in archaeology started in the 1960s with the "New Archaeology," which included the analytical perspective (Kvamme, 1995; Aldenderfer and Maschner, 1996). It has further gathered pace over the past 20 years. With the development of technology, spatial analyses and designed maps made with the help of GIS, the use of GIS in archaeology spread considerably. Solutions to certain problems have been sought through GIS including the issue of determination of mounds lost at earth level (Demir, et. al., 2006), scio-cultural interpretations of archaeological landscape (Rennell, 2012), digitization and visualization of archaeological data (Zhang, et. al., 2007). GIS, as the tool of spatial analysis in archaeological research, has a place in truer and more rational planning (Uysal, 2008). Moreover, using GIS provides advantages to archaeologists in terms of resource saving, timing and workforce (İderman, 2006).

Various studies have been conducted on archaeology and the integrated use of GIS including the examination of the geomorphological and spatial analyses of Hygassos in the middle Mediterranean (Oğuz-Kırca and Liritzis, 2017), the calculation of chronological development at the regional scale and different post-depositional processes (Fernandez, et al., 2016), three dimensional recording, processing, modelling, visualisation and representation of an ancient building or an archaeological data with the help of GIS (Tsiadaki and Michailidou, 2015; Dell'unto, 2016), determination of archaeological interest based on archaeological data, geospatial analysis and predictive modeling (Balla, et. al, 2014), spatial distribution of archaeological sites with GIS (Gao et al., 2009), and restoration and restructure of archaeological settlements with spatial analysis methods (Liu, 2007). There are many registered protected

archaeological sites that are used for tourism and scientific studies in Turkey. In these sites, there are studies analyzing historical and current land use (İderman, 2006), planning touristic routes (Çuhadar et al., 2013), determining the characteristics of the archaeological sites (Ozulu et al., 2007), restructuring the settlement pattern (Oğuz-Kırca, 2014) and creating the database design (Levent, 2009; Kardeş, 2010) in which archaeology and GIS are used in an integrated way. Moreover, there are also studies screening the antique distribution with the help of GIS (Kıroğlu, 2003) and improving the Spatial Decision Support System (Baybaş, 2013) in Knidos ancient city, which is the selected application territory in southwest Turkey, in the Datça district of Muğla province.

The aim of this study, different from the studies in literature, is to analyse the rationale for the spatial site selection of the historical structure in terms of the characteristics of the site and its topography, using the techniques of GIS. The spatial analyses that are made with this study will contribute to archaeologists and researchers from different disciplines in terms of topographic conversancy and interpretation of the city.

## 2. MATERIALS AND METHODS

The Aegean region in Turkey became a centre of life and trade throughout history because of its geographical and strategic position. Especially in the ancient age, coastal towns that were important centers of art, culture and trade were located in the region of Karia (or Caria), which was named after Kars (or Cars), which has uncertain origin (Pişkin, 2007; Büyüközer, 2012). Knidos ancient city, which was founded in the 4th century BC, was one of the most important military and commercial cities in the Karia region. Figure 1 shows the location of Knidos ancient city in Muğla in Turkey.



Figure 1. The location of Knidos ancient city

Knidos ancient city is named "double city" because of the island settlement, which is called Kap Krio, in front of the mainland (Doksanaltı, 2006; Büyüközer 2012). The island had a view of the peninsula and united with the continent over time. The city locked two hillsides between the island and the continent. Agricultural practices (hanging gardens for wine production and olive farming) carried out in the city's limited geography, land use methods and coastal town characteristics made Knidos one of the most important commercial and religious centers in its time (Love, 1968; Döger 2004). For this reason, the planning form that was created in its limited geography and spatial site selection of the historical structure was significant for researchers.

In this context, the aim of this study is to realize the locations that are confirmed to have hosted con-

structions in the ancient city, and to analyze the site selection reasons for these locations. For this reason, a digital elevation model that reveals the topography of the city was constituted. DEMs provide the quantitative projection of a topographic surface and topography is accepted as the most important factor in the settlement selection of human beings from past to present (Pişkin, 2011).

While the digital elevation model was being created - with the shape of thick-in-uneven areas and thin-in-flat areas - the location of 4,500 points was determined with the Network RTK application. From coordinates obtained with NRTK and with the help of ArcGIS 10.2 software, a digital terrain model was attained. The DEM of the ancient city was created from 3D coordinates data processed digitally (Figure 2).

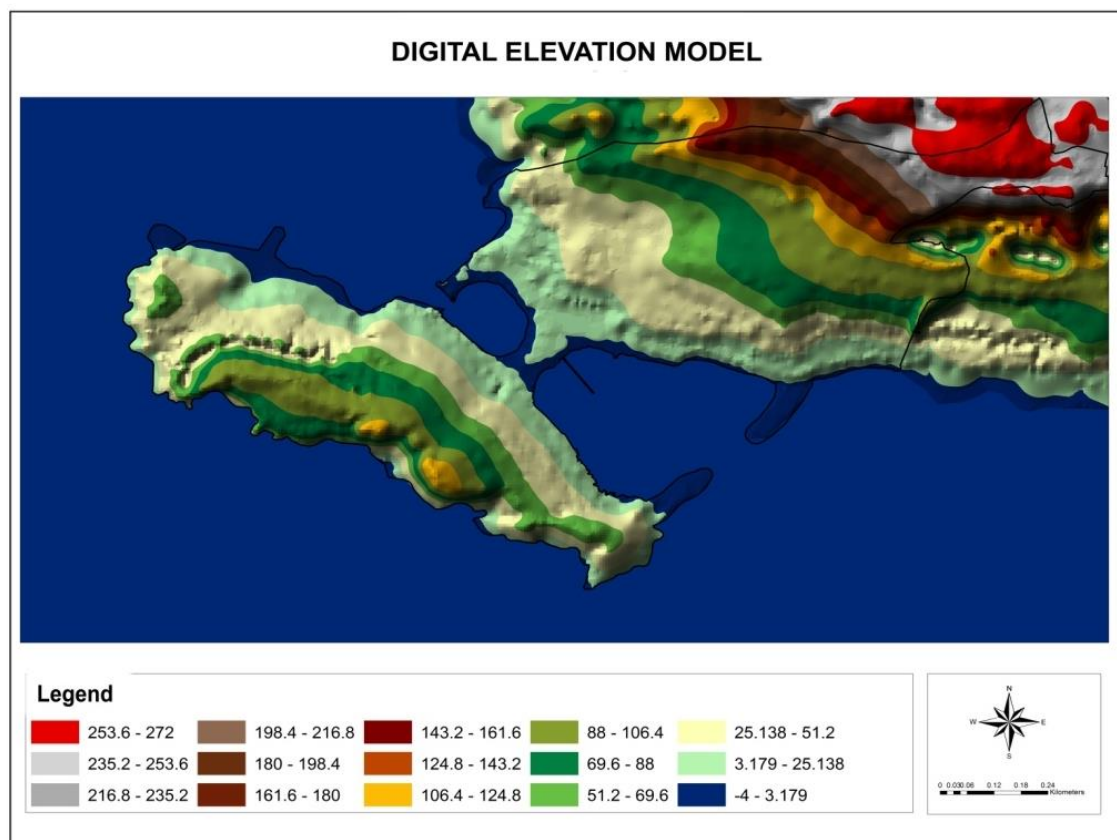


Figure 2. Digital elevation model of Knidos

In the study, database design was made towards the spatial and attribution data (historical structure, the name of area, situation of the historical structure and raster view) for each detail that reflects the characteristics of the ancient city. Database design, created in the archaeological areas, is important in terms of preventing the disappearance of cultural values, as well as their recording and archiving, tourism, and presentation preparation purposes (Levent, 2009; Girişken, 2010). Apart from the data acquired

with the field survey for the database design, raster sheets and data regarding the area were provided by the Governorship of Muğla, the Ministry of Environment and Urban Planning Provincial Directorate, and Online Base Map. The data was collected with the help of ArcGIS 10.2 software and a data layer was created. Furthermore, 3D mapping was realized in order to increase spatial readability for tourists and researchers (Figure 3).

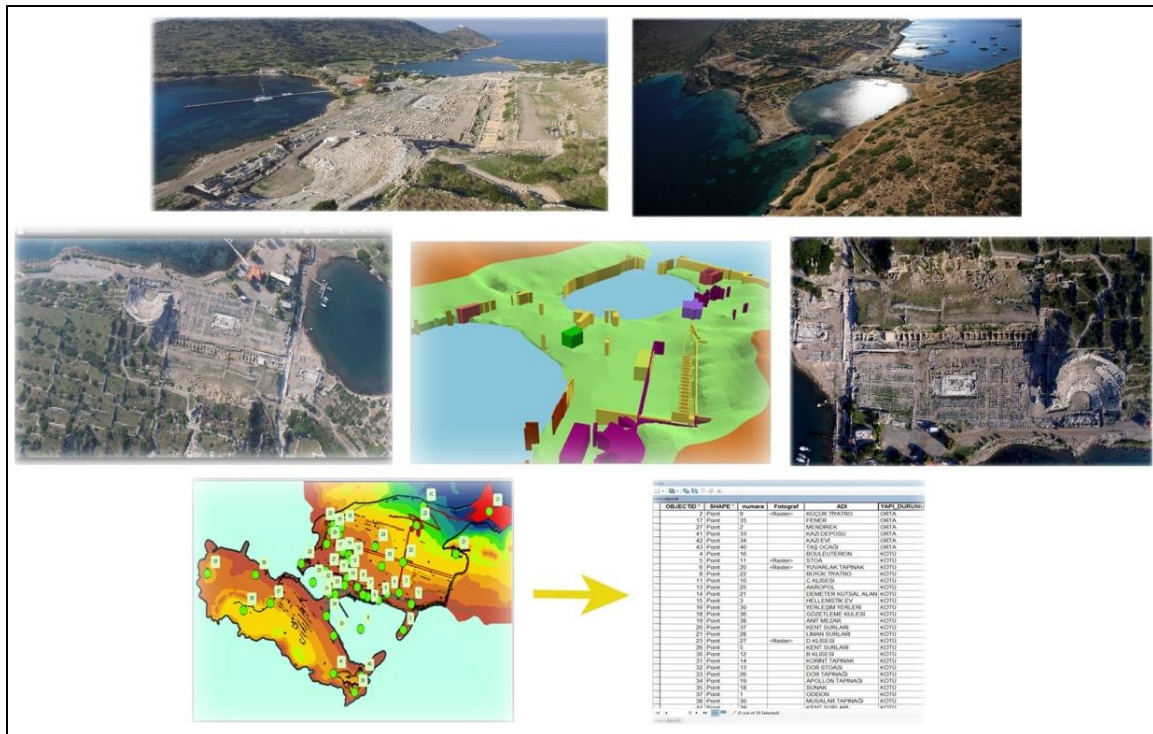


Figure 3. Database design of Knidos

Finally, application planning in the Knidos ancient city and the reasons for spatial site selection of the historical structure were examined with the help of GIS through DEM and the spatial analyses database.

### 3. SITE SELECTION ANALYSIS OF KNIDOS ANCIENT CITY'S HISTORICAL STRUCTURES

Wars, natural disasters, rising population levels, the geomorphologic structure and the geographic structure all have a role in the ordinate planning of cities and the site selection of historical structures (Özer, 2011; Büyüközer, 2012). Especially after the establishment and planning of these cities, the opportunities of trade also have a place in terms of continuity. In general, a political centre (acropolis) and a religious centre always existed in these cities and suitable places were planned as agoras (an open space that served as a meeting square for various activities of the citizens), churches, temples, theatres, gymnasiums, etc. The remaining places were reserved for housing settlement (Braudel, 1990; Wycherley, 1991; Mazi, 2008).

Hippodamos, who was the most famous person in understanding urban planning in ancient Greece, produced a universal urban model called the grille plan (Mazi, 2008). This model aimed for the physically compatible, straight, easy and equal partition of terrain in the city.

While the gridded plan is generally seen as a possible model for generally flat terrain, the most important example applying the gridded plan in uneven terrain is Knidos (Büyüközer, 2012). There is therefore a special importance of geographical formations in the spatial site selection of structures for Knidos (Özer, 2011). This study aims to analyze the application of the gridded plan in the uneven geography of Knidos and analyze why the spatial site was selected. In line with the aim of study, the site selection reasons for structures were analyzed through spatial analyses (slope, aspect and visibility) in Knidos ancient city.

- Firstly, to understand how the slope was used in Knidos planning and site selection of the historical structures, slope analysis was carried out (Figure 4).

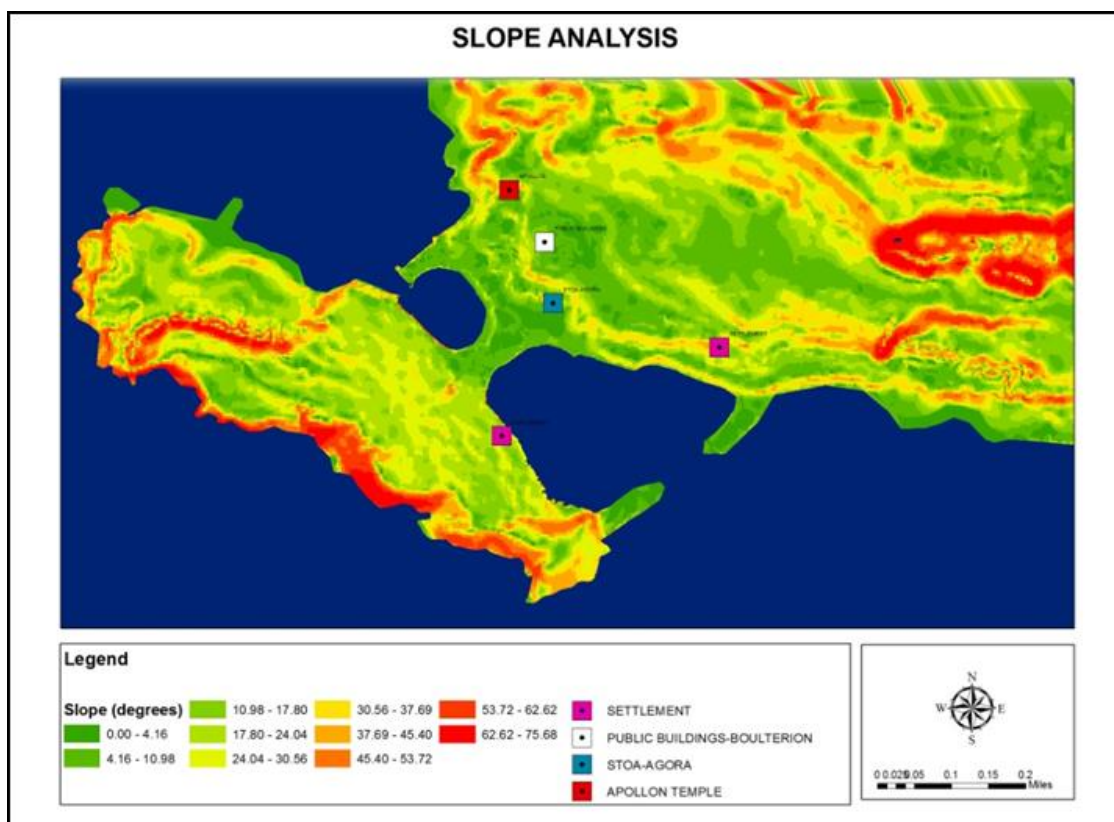


Figure 4. The result of slope analysis of Knidos

According to slope analysis, the height of the city ranges between 0 and 280 meters. The eastern part of the peninsula is surrounded by crags, while the western sides is surrounded by high mountain chains. Although most of the land is surrounded, the city was founded on two hillsides.

Firstly, in constitution of the fortification wall to determine borders of the city, the benefits of the slope can be seen. These walls were constructed at the peak point according to the topography of terrain. These points were selected because they were difficult to access from the sea and thus easier to defend. Fortification walls were built in the hills unifying the sloping peak points of the city and providing low-access, high slopes in defense of the city. In Kap Krio, the walls that encircle the military port in the continent extend over the acropolis, supporting with built towers.

Secondly, the site selection of the acropolis, the agora and public structures benefited from the slope differences. According to Aristoteles, the acropolises that the government placed represents the oligarchy and monarchy, while general the low-rise and flat places were convenient for democracy (Mazi, 2008). To this ideology, using hills for acropolises and flat places for agora (to talk about democracy), were geographical attraction fields. When slope-function analysis is examined, it can be seen that the acropolis was placed in the high-sloping region and extends

across the city walls, while the agora was placed in the lower and more flat region. This ideological reasoning in the site selection of the agora was combined with the idea of unifying it with the port, which is focal point of the city. Because of the wide scope necessity in other public areas, they selected the area around the agora with the lowest slope.

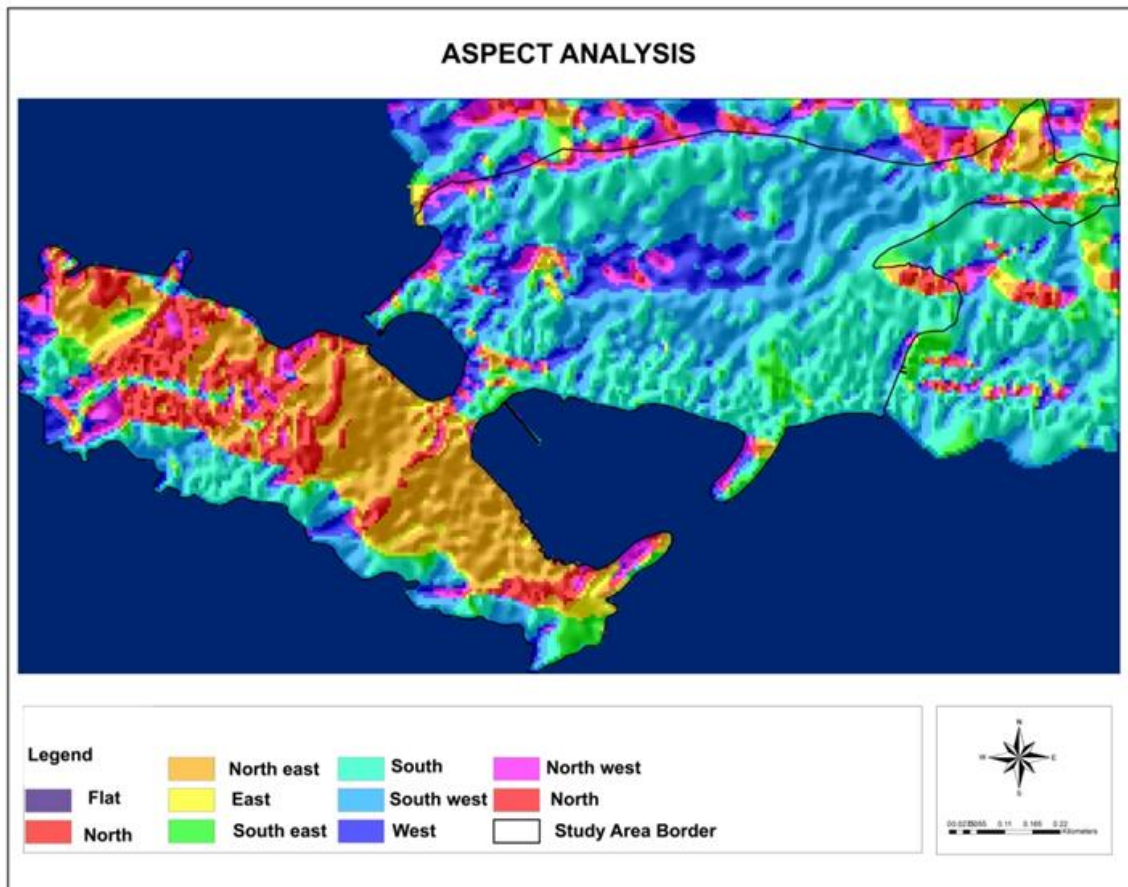
Another structure group that the slope does not obstruct in Knidos' planning is the housing settlements. Suitable areas were created to make terracing in order to apply the grille plan in the northern hillside of the Kap Krio and in the continent, which forms part of the southern public area to the fortification walls because of high sloping (Doksanaltı, 2006). In this way, we can say that the continent and public areas remained the focal points of the city compared with housing areas in Kap Krio, with the agora and port unified (Büyükozer, 2012).

Along with creating housing settlements in sloping terrains of Knidos, locals also benefited from terracing in expanding the cultivated area. They therefore made the topography suitable for agriculture. Thanks to viticulture in the area, Knidos became the largest wine producer in western Anatolia (Pişkin, 2007).

The geomorphological factors have had a greater effect on settlement patterns and socio-economic development since the Hellenistic period for Karia cities (Oğuz-Kırca and Liritzis, 2017). In this study, it

is seen that the Knidos planning and site selection of the historical structures were affected from the geomorphological factors.

- Aspect analysis was carried out to understand how to benefit from the aspect in site selection of the historical structures locations and planning of the Knidos city (Figure 5).



*Figure 5. The result of aspect analysis of Knidos*

The aspect analysis confirmed the city's continental characteristics and its southern, southwestern and western aspects. The continental part of the city is sun sloping, with high temperatures, long sun-receiving and short snowfall times. In this part of the continent, houses located on the terraces for the creation of the grille plan are in a good position for receiving sunlight. On the terraces constructed for agricultural purposes, the ripening time of agricultural products is short because the duration of sun-receiving is long.

The island part of the city is generally enclosed with scarpred rocks. In general, it has been confirmed

that this part of the city has northern and northeastern aspect characteristics. Farming terraces were constituted on hillsides west of the island's big harbor, which is not arable. These terraces, which had low agricultural productivity, aimed to prevent erosion against the port, to reduce water loss during rainfall, and to provide convenient access for agricultural products to the port market (Pişkin, 2007).

- Visibility analysis has been carried out in the Knidos city planning and site selection of the historical structures to understand the importance of visibility (Figure 6).

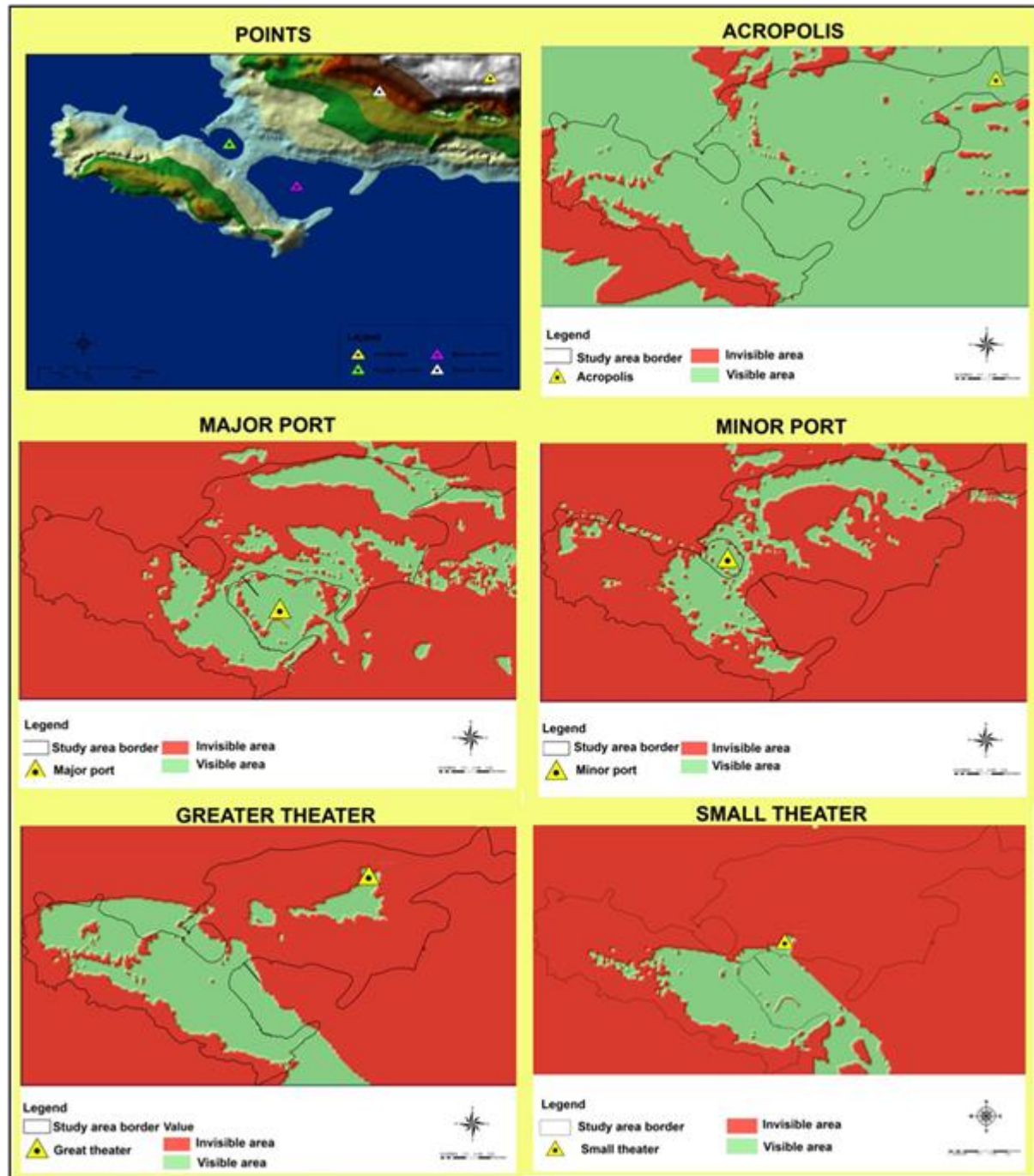


Figure 6. The results of visibility analysis of Knidos

In Knidos ancient city, defense, trade and architecture were quite effective in shaping of the urban area. The acropolis was placed in a dominant location in order to defend the public order in the city. Visibility analysis shows that the acropolis was positioned to be visible to almost 90% of the city. As the eastern part of the unseen half island is surrounded by steep rocks, these areas were followed by sight watches.

For Knidos, the most important construction affecting the shape of urban planning with the trading features was the focal point port. Knidos has two ports that are naturally shaped according to topographical features and functioned for trade purposes in the east and military purposes in the west. These ports, where were part of the East Mediterranean trade route, were also important in terms of sea transportation to the city, which was difficult to access by land. For this reason, one of the ports was

used for defense and military purposes. According to the visibility analysis, the military port was highly sheltered and the coastal areas of the half island were largely visible from the military port. The commercial port was more vulnerable, in a large basin. From the trade port, the continent and coastal parts of the island were visible.

Apart from the functions of defense and trade, in ancient cities it was very important to show the settlement's architecture and power. The centuries-long combination of architecture with political power began in cities ((Mazi, 2008). For this reason, visibility analysis was especially carried out on particular architectural structures (including the theatres, ports, etc.). According to the visibility analysis, the choice of place in the trade port, apart from features such as the slope, direction, wind direction and morphology of the area, which the theater should have, is accepted as one of the important features of the main city.

#### 4. CONCLUSIONS

The aim of this study was to examine the ideas behind the planning of Knidos, one of the port cities of

the Karia region in ancient times, along with the features of the space. Spatial analysis with the help of GIS in this context shows that the ancient city of Knidos was used by ancient settlements for a number of reasons. These reasons can be listed as follows:

- To constitute terracing in order to achieve the grille planning figure of that period.
- To spread historical structures to specific areas according to their functions and topography.
- To present a visual attraction.
- To make the port a focal point and to increase house-port accessibility.
- To unify the structures of the harbor, agora and trade centers.
- To give ideological meaning

According to this, the slope, aspect and visibility elements in site selection of the historical structures were placed with in line with the purpose of agriculture, trade, social relations and defense, and turned the limited geography into an advantage for the city by using the correct strategy.

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