

# USING SPATIAL TECHNOLOGIES TO EXPLORE ARCHEOLOGICAL SITES: A STUDY OF THE ANASTASIAN WALL IN THRACE, TURKEY

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## ABSTRACT

The increasing interoperability and usability of GIS, Remote Sensing and GPS programs and the availability of a high resolution images has enabled new archeological sites to be discovered and additional findings within existing sites. Spatial technologies have enhanced the ability to map, ground truth and spatially document structures and artifacts associated with known archeological sites. However, many archeologists and others who study historic sites are only now realizing the potential of spatial technologies to assist them in their research. This study applied Remote Sensing, GIS and GPS technologies to study the Anastasian Wall in Thrace, Turkey. The Anastasian Wall was constructed prior to approximately 500 C.E. by a variety of Byzantine emperors. However, the majority of the wall was constructed apparently during the reign of Anastasias (491-515 C.E.)—hence the name ‘Anastasian Wall.’ It was approximately 50 kilometers long, ranking as one of the longest walls in ancient times, but is relatively unknown— as compared to the Great Wall of China or Hadrian’s Wall. The wall consists of earthen mounds, stone/rubble walls, towers and ancillary buildings. However, this unique cultural monument is being threatened by modern farming, road construction— increasing exurban and suburban development, mining and forestry. Although a significant portion is no longer visible, approximately 20 kilometers is still evident—making it an impressive historic architectural structure. It is crucial that the wall is more extensively documented for future study and a basis for more extensive protective actions (i.e., creation of a national historic park.) Through the combined application of GIS, Remote Sensing and GPS, the authors were able to create a geographic database of the wall, identifying where there were: visible structures, structures beneath the surface or underwater; and areas which need further on-site investigation. The study demonstrates that spatial technologies have an integral role in the documentation of archeological sites, greatly augmenting and in some cases surpassing traditional surveying and mapping techniques used in archeology.

**Keywords:** Remote Sensing, GIS, GPS, spatial technologies, archeology, Anastasian Wall, Byzantine History, cultural resource management

## 1. INTRODUCTION

This study applied Remote Sensing, GIS and GPS technologies to study the Anastasian Wall in Thrace (Trakya), Turkey. The Anastasian Wall was constructed about 500 C.E. by a variety of Byzantine emperors. However, the majority of the wall was constructed or reconstructed apparently during the reign of Anastasias (491-515 C.E. (Willams and Friell 1998). It was approximately 50 kilometers long, ranking it as one of the longest walls in ancient times, but is relatively unknown— as compared to the Great Wall of China or Hadrian’s Wall. The wall consists of earthen mounds, stone/rubble walls, towers and ancillary buildings. It is being destroyed due to farming, suburban/exurban development, mining, road building and forestry. It is crucial that the wall be further documented for future archeological investigations and for the basis for protective measures.

The study demonstrates that spatial technologies have a crucial role in the documentation of archeological sites, greatly augmenting and in some cases surpassing traditional surveying and mapping techniques used in archeology. This is a unique historical area . There are only two only cases similar to this: Hadrian’s Wall (U.K.) and The Great Wall of China. However, while China and the U.K. have protected and promoted their historic walls, Turkey has neglected its historic and unique wall.

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## **2. BACKGROUND**

### **2.1. History of Anastasian Wall**

The primary purpose of the wall, which stretched for approximately 50 kilometers from the Black Sea to the Marmara Sea in Thrace, was for defense against invading tribes. Most sources attribute

the walls to the Late Roman/Early Byzantine Emperor Anastasius who appears to have constructed or reconstructed the wall about 500 A.C.E.—thus the name of Anastasian Wall. However, there is some evidence that a portion was built early by his predecessor Zeno (Williams and Friell 1998).

Beginning at approximately 5<sup>th</sup> Century, the western portion of the Roman Empire were facing increasing pressures from hostile groups (Huns, Bulgars, Vandals, etc.) and was beginning a slow decline into what would be later called the Middle Ages or Feudal period—which was a period of almost continual warfare among a pageant of a changing group of nations. Previously, the Empire had been able to maintain a semblance of its former form by making treaties, bribery or incorporating the tribes into the Empire. The western portion of the Roman Empire by this period was significantly weakened, while the eastern portion was still prospering. The term Byzantine Empire was coined later by historians. The Emperors of the eastern portion of the existing Roman Empire perceived themselves as continuing the legacy of the Roman Empire and protectors of ‘true Christian faith’. Since the time of Constantine the Great, Rome had ceased to be the capital of the Roman Empire and was supplanted by Constantinople (modern day Istanbul) as its capital. Rome’s wealth steadily declined due to several raids led by a variety of Germanic tribes. However, Constantinople increased its wealth and by the 5<sup>th</sup> Century, it was the wealthiest city in the world and was a great prize for raiding groups (Williams and Friell, 1998).

Theodosius had built a wall around Constantinople in 400 A.C.E. and it had effectively defended the city. Anastasius who was a prudent emperor perceived that another wall would be the first line of defense against the tribes who wished to attack and raid Constantinople. The Bulgars had often raided the towns in Thrace and by the late 5<sup>th</sup> Century, their activity was increasing. Their interest was not territory, but loot. About 500 A.C.E., Anastasius started the construction of the set of walls stretching from the Marmara to the Black Sea. It was later reconstructed by Justinian. Both emperors also encouraged the construction of city walls of cities in the vicinity of the wall (i.e. Selymbria-modern day Silivri). However, after about 700 A.D., it ceased to be manned because of the cost of maintaining and supplying troops along the wall, and a decreased threat from the west. (Williams and Friell, 1998).

### **2.2. Archeological Surveys**

Until recently, the wall was not well documented. The first major archeological exploration of the wall was begun by the Archaeology Department of the University of Newcastle led by James Crow in the late 1990s. The wall was followed by the Newcastle team from its beginnings at the Marmara to the Black Sea (University of Newcastle 2005). Some of the visible portions of the wall were measured with a GPS portable station including some of the major forts. The most well preserved portions of the wall were in the center and the northern sections. In these sections, one can see portions of regularly hewn blocks amid ivy and other vegetation that grows along or on the walls (See Figure 1). The southern section exists as mounds (See Figure 2). At various places along the wall, there is evidence of other structures such as fort complexes. The evidence of underwater dock structures at the southern end has been documented by James Crow and his team (University of Newcastle 2005). Despite, significant portions of the wall being destroyed or covered by mounds, the visible remains are still impressive.



**Figure 1:** Portion of Wall in Northern Section (photo by Sinan Kocaman)



**Figure 2:** Mound Wall Portion in Southern Section (photo by Sinan Kocaman)

### **3. SPATIAL TECHNOLOGIES AND ARCHEOLOGY**

The use of spatial technologies has been found to be tremendous tools for archeologists (Wiseman and El-Baz 2007) (Montufo 1997) (Capro 2002). The combined tools of Geographic Information Systems (GIS), Remote Sensing and Global Positioning Systems have been able to document archeological sites much better than previous methods. Remote Sensing, which includes images taken from satellites and aircraft, has help to discover many sites that were previously hidden. Other Remote Sensing instruments such as Side-looking Airborne Radar (SLAR) and Ground Penetrating Radar are also proving to be invaluable tools for archeologists. High resolution images have revealed greater detail than was gained via lower resolution satellite images. Spatial technologies have enabled an increased awareness of archeologists so that many are beginning to view archeological sites not as isolated places with artifacts, but part of a historic physical and human geographical context.

The use of GIS supports additional analysis capability. Using a vector GIS can clarify the spatial relationships of building-, artifacts and topography within archeological sites, once are delineated via image processing. The use of GPS to survey sites and record other information and their intergration with Remote Sensing and GIS systems provides additional information.. Other analytical methologies

ties to spatial technologies such as fractal analysis are creating a more robust toolbox for archeological investigations (Brown, Witschey and Liebovitch 2005)

## 4. STUDY AREA AND METHOD OF ANALYSIS

### 4.1. Study Area

The study area is a buffer of 2 kilometers on either side of the wall line. The subset image was cut approximately to be the presumed area of the wall before delineating the wall corridor. This area is approximately 24 kilometers wide and 60 kilometers long, an area of approximately 1,340 square kilometers. The wall line is approximately 50 kilometers long. The concentration was mainly on the wall and related structures.

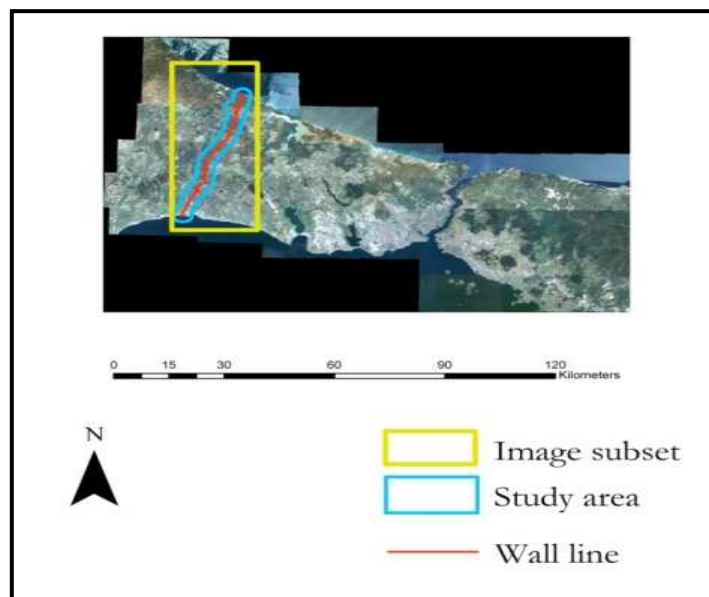


Figure 3: Study area

### 4.2. Methods of Analysis

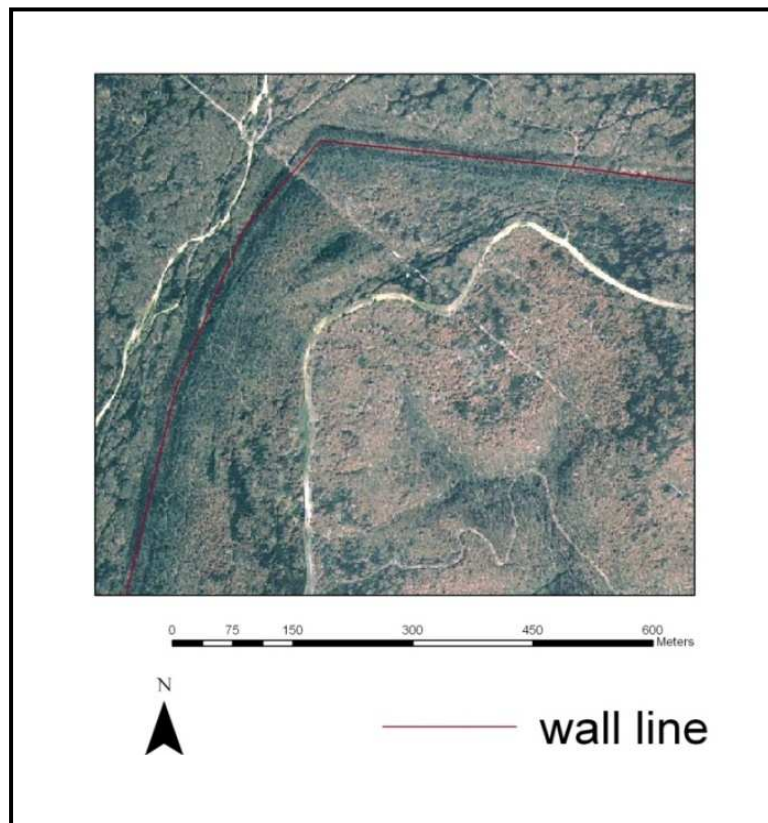
To determine the general area of the wall, a map and information gathered by the University of Newcastle (University of Newcastle 2005) was consulted. For the analysis conducted for this study, an IKONOS images from March 2004 and September 2007 of Istanbul province was used. The image from 2007 included an infrared band. A subset of the image that only included the area surrounding the possible area of the wall was created using ERDAS (See Figure 3.) The image was imported into ArcGIS and the visual evidence of the wall was digitized. Further subsets were created for further analysis use ERDAS. Unsupervised classification (Gibson 2000, Tso and Mather 2001) and other image analysis (such as principle component analysis) were performed within the study area and addition subsets. By image processing, it was possible to determine the wall corridor. In addition, a 3-D version of the wall was prepared using ArcScene to place the wall to visualize it in a topographic context.

## 5. RESULTS

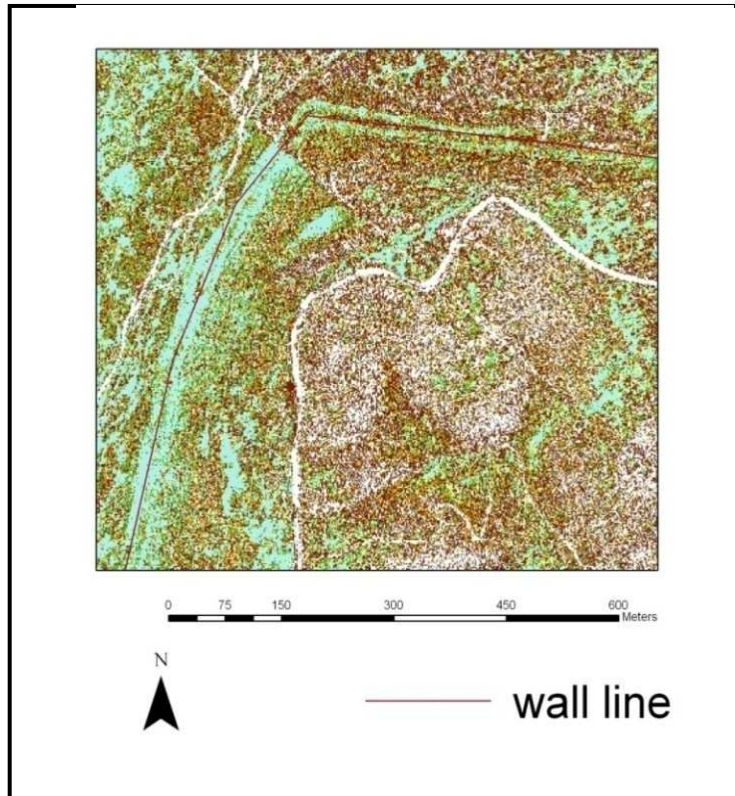
By false color images, enhancement techniques (i.e., principle component analysis) and unsupervised classification, most of the locations of the wall were identified. In some cases, such as the southern end of the wall, there were evidences of mounds or disturbed soil that indicated the presence of the wall. The accuracy of locations in these areas are at times questionable and warrenting futher on-site verification. The most well preserved area of the wall was found in the center and nothern area. In these areas, it was clear where the wall is located in this area via visible inspection of the images.

Classification of the images reveals further details about the vegetation that is located on or near the wall and where there are exposed sections. In some cases, other structures such as forts and unidentified buildings can also be identified through classification methods. Given the page constraints for this article, it is impossible to display all the sections of the wall via visible and classified images or give detailed analysis of the findings. The next paragraphs will briefly examine some of the findings of selected areas of the wall to serve as an example of the use of remote sensing in investigating the wall.

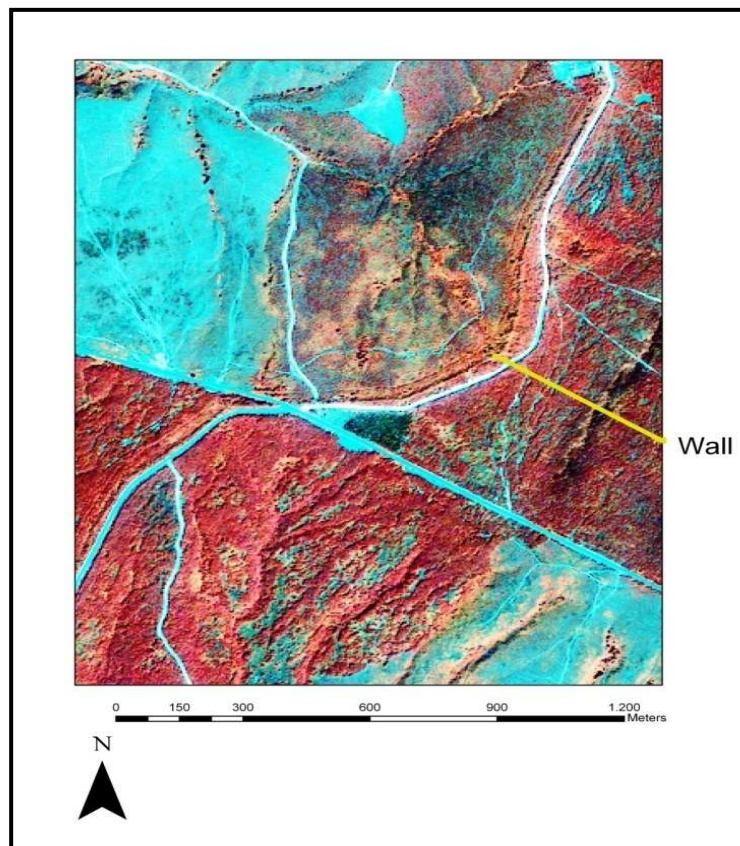
Figure 4 shows a section of the northern portion of the wall. The wall is identified by dark linear patterns. Other similar linear marks in the center of the image that could be a fort associated with the wall. When the image was classified using unsupervised classification, the wall area appeared as a lineal unit of classes associated with vegetation. Nevertheless, there were other areas of vegetation that had the same signature. (See Figure 5.) The linear patterns are areas of dense vegetation, mainly brush-as noted when the authors visited sites of the wall.



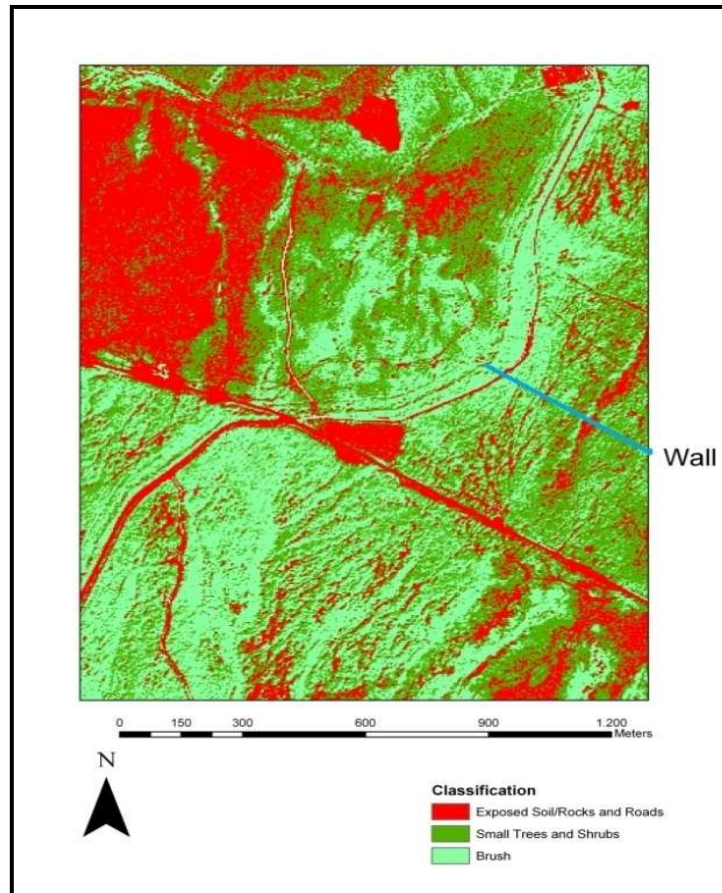
**Figure 4:** Northern segment of wall



**Figure 5:** Unsupervised Classification of Same Northern Segment



**Figure 6:** Central Wall Section (with Infrared Band)



**Figure 7:** Same Central Wall Section Classified

With the use of images with infrared bands, other attributes of the wall can be discerned. In Figure 6, an area of the image with infrared bands is displayed. In this image, the wall is identified as a dark area surrounded by lighter areas of red. The blue areas are those that have high reflection values such as bare soil and roads. When this image was classified using unsupervised classification, a much clearer picture of the composition of the vegetation was made apparent. Brush and small trees/shrubs and highly reflective surfaces are distinctly separated. The area of the wall is a mixture of exposed soil/wall and small trees surrounded by brush. This was verified by the research team.

### 5.1. Use of 3D Visualization of Wall

The location of the wall can be combined with 3-D visualization techniques to give one an impression of how the ruins relate to the landscape and how they would have appeared. It must be noted that the landscape has changed somewhat since the time of the construction of the wall. Figure 5 shows a visualization of the northern section of the wall area near the Black Sea. There were indications of structures on the cliff overlooking the Black Sea with two sets of walls leading to these fortifications. At the lower end of this area is a small triangular fort.

## 6. CONCLUSION

From this brief discussion, it is easy to discern the value of using Remote Sensing and GIS for the analysis of archeological sites. In the case of the Anastasian Wall there are clear evidences of the wall in the northern and central sections. However, in the lower sections, using visual inspection is often insufficient and other image analysis techniques were utilized such as image enhancement or classification methods to determine the wall area. The use of infrared bands proved to be useful in determining the vegetation types associated with the wall which will be a guide in locating additional structures.



**Figure 8:** 3D Visualization of Northern Section of Wall

It should be apparent to the readers that the wall is of significant historical and architectural importance. It stands along with other ancient long walls such as the Great Wall of China and Hadrian's Wall as worthy of being preserved and protected. Unfortunately, the Anastasian Wall is being ignored by the Turkish Ministry of Culture and the world archeological community and is being threatened by modern development. If it was not for the efforts of James Crow and his team, the wall would have gone unknown to the authors and others. There needs to be more documentation and investigation of the wall using spatial technologies and on site archeological digs. This wall and the corridor should be given special status by the Turkish Ministry of Culture, restored in key locations and be recognized as unique historical and architectural site along side with other world class archeological sites in Turkey. Otherwise, it is certain that the wall will be another victim of the creeping exurban and suburban development of greater Istanbul.

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