Project Main Area : GEOGRAPHY

Project Thematic Area : STEAM

Project Name (Title) : Creating a 3D Map of Attractions for the Visually Impaired Using GIS and Python

1. Summary

Today, the integration of disabled people into society continues to be an important problem. “Yellow pavement, disabled ramps, etc.” that support this integration and facilitate the process . There are various applications. However, although there are areas where the use of these applications is not sufficient, there are situations where it is not a very effective solution method. One of these situations is uninhabited places such as “prairie , plain, archaeological sites , open-air museums”. For such places, solutions must be found for individuals whose vision and some physical functions are not healthy. Especially the visually impaired will be able to recognize the landforms and the works of open air museums by moving their hands with the 3D map created in the project. In this way, a contribution will be made to their integration into the society. For this 3D map , the geomorphological structure of the place to visit was obtained with the DEM data obtained from the Geographical Information System data (Vector and Rather) python obtained from Google Earth . A rather type of geomorphological structure obtained was created. The map created with the Rather type and the relief and isohips map of the same place were combined. 3D modeling of the created map was made. This created 3D model was applied in the ancient city of Aphrodisias on a visually impaired individual who received the Governor's Permit . The 3D model created as a result of the application, the desired result was achieved on the visually impaired individual.

Keywords: GIS,Python ,Sight Disabled,Aphrodisias Ancient City,3D model map

2. Purpose

It is a big problem for people with disabilities to be able to recognize artifacts in museums and to visit museums without a guide. However, no solution has been found for such a problem in open-air museums. It has been observed that the relief maps in the museums are not sufficient. In addition, very high amounts are paid when creating a relief map of any part of Turkey, and both the models created are not serial and the accuracy percentage of the created map is not sufficient. While visiting open-air spaces, 2D brochures as a guide have sometimes been insufficient to reflect a 3D space and therefore make their users suffer.

Therefore, the aim of the created project is:

1-) Visually impaired individuals can visit open air spaces by understanding their location and directions with a 3D mini relief map,

2-) In order to create a relief map of any place in Turkey , the 3D map of a place in Turkey and even in the world with a high percentage of accuracy and a cheap cost,

3-) To create a simple mini-schematized map for the users visiting the open air places and to develop a new method that will ensure that the users will not be victimized.

3. Introduction

Definitions:

Geographic Information Systems: Geographic Information Systems (GIS) in terms of its basic functions, can be defined as a tool used to combine a location where an object is located or an event occurs with combined, referenced , ordered and analyzed information in various structures. In this tool, reality is expressed with maps where each semantic data or related event has a spatial component directly or indirectly . GIS allows location-based information to be collected, maintained, managed and processed automatically in a planned systematic (Uçar and Doğru , 2005).

ArcGis : ARCGIS technology is a scalable integrated Geographic Information System software (Esri Arcgis , tb .) developed by ESRI.

There are programs such as ArcMap and ArcScene in ARCGIS technology .

Disabled: The definition of disabled is defined as "those who cannot do the work that needs to be done on their own in the social life of the person, as a result of physical or later deficiencies" (Bilge, 2017).

Blind: Persons who have a significant decrease in visual acuity that cannot be medically corrected due to congenital or subsequent causes and therefore cannot continue their lives without support are defined as "Visually Impaired".

According to the tariff made by the World Health Organization (WHO); If the vision is less than 0.3 and/or the visual field is narrower than 20 degrees in the well-sighted eye despite correction after medical and surgical treatment, the vision is poor. (Edremit Municipality, tb .)

3D Printer: They are devices that enable the data stored in the computer environment to be converted into physical real objects. This technology can also produce geometries that cannot be obtained with traditional manufacturing methods (Şahin and Turan, 2018).

3.1. Disabled people

is increasing day by day due to the increase in the aging population worldwide, natural disasters, wars, accidents or some congenital reasons. It is estimated that approximately 15% of the world population lives with some kind of disability (Yeşilyurt, Kırlar and Lale, 2014).

3.1.1. Visually Impaired data in Turkey

it is known that 8.5 million people, 412 thousand of whom are visually impaired, ie 12% of the population are disabled . It is assumed that 1000 of them are visually impaired (Yeşilyurt et al., 2014).

3.1.2. Institutions for the Visually Impaired in Turkey

There are certain organizations established in Turkey to reduce the problems experienced by the visually impaired. The main ones with their vision and mission are as follows:

1-Turkey Visually Impaired Association (TURGED) was established in 1970. It is an organization with certain missions. Among its missions, it has many missions such as making legal arrangements that eliminate the disadvantages of the visually impaired and ensuring their full participation in social life (TURGED tb .).

3.2. Problems Experienced by the Visually Impaired

Şat and Göver (Cited by Kozan,Kesici and Bozgeyikli , 2018) Applications arising from the design of houses, living spaces or natural environment reduce the quality of life of especially disabled individuals. It shows itself in furniture. While cities mostly allow vehicles to move quickly, public transportation vehicles also cause great problems for visually impaired individuals . Underpasses and overpasses that are not designed for the disabled prevent

individuals with disabilities from participating in social life. In addition, sidewalk heights, ramps, furniture on the sidewalk and vehicles parked on the sidewalks create many difficulties for the visually impaired in urban life.

3.2.1. Problems Visually Impaired Experienced in Open Air Museums

The museum is the place that contains the objects, memories and all experiences of every area of life; It is one of the most important non-formal education institutions where lifelong learning takes place. With museums, exhibition halls, conference halls, libraries, we come across as places that are located right in life, living and making the world they live in in the most effective way (Buyurgan, 2017).

Visually impaired people experience great difficulties while visiting open air museums. For example, when visiting the open air museums outdoors, the landforms outside affect the visually impaired negatively . It is a significant risk for the visually impaired to visit the open air museum without a guide in the face of situations such as pits, hills and soil dents.

3.3. Integration of the Visually Impaired into Social Life

number of problems faced by the visually impaired in social life have been referred to and highlighted under the above headings. " Integration into Social Life", on the other hand, appears as a social life taboo as a completely different subject . "World Disability Report; It proposes steps to be taken for all relevant stakeholders to create conditions that will remove barriers for the benefit of people with disabilities and the whole society, to improve rehabilitation and support services, to provide adequate social protection, to establish inclusive policies and programs, and to enact existing and new standards and laws. In the past, while the disabled were described as individuals who needed to be helped, the logic of assistance has left its place to a rights-based perspective today. However, incomplete and erroneous practices of public institutions, the lack of sufficient information about the rights of disabled individuals and their families, and their limitations in seeking rights prevent them from adapting to social life. Anlı (Translated by Genç , 2015)

3.4. The Effect of the Model Created in the Project on the Social Integration of the Visually Impaired Individual

As it can be understood from the personal interview with E.YÜKSEL, on the subject of "integration of the visually impaired in social life", where the created model was tested, it was understood that one of the most important problems in the integration of the visually impaired is the differences between the visually impaired and healthy individuals E.YÜKSEL (personal communication, 12 January 2022 It has been observed that the 3D map made in line with the use of E.YÜKSEL in the project reduces the difference between a visually impaired individual and a non-disabled individual. From the conversation with E.YÜKSEL, it was understood that this project made a positive contribution to social integration. If it is expanded with applications, it also has the potential to play a big role in the development of social life integration.

3.5 . Previous studies

Selin Vulga et al. A system has been developed for The purpose of this system is to bring back the individuals whose freedom of communication is restricted (Vulga,2020).

In the project named "Design of Wearable Distance Meter Using High Frequency Sound Waves for the Visually Impaired", created by Sevgi Arı, who made her Master's Thesis, there is a

project that aims to minimize the problems that occur for individuals with congenital disadvantages (Arı, 2016).

In the project titled "Teaching Map Knowledge to 9th Grade Total Visually Impaired Students Studying in Inclusion Environments" by Murat Tanrıkulu, the equator, prime meridian, other meridian and parallels and polar points were scanned with transparent silicon to make them embossed and perceptible. (Tanrikulu, 2011).

According to the comparison-based information obtained from these projects for the visually impaired, the features that distinguish this project from the others are:

1- Use of a 3D map created in innovative ways.

2- To have prior knowledge of the area to be interacted with.

3- It contributes to the visually impaired individual's sense of touch and to have an idea about the isohips and elevation information of the desired region.

3.6. Research Question

In order to reveal the problem, the sample group of the visually impaired, who is the main target group of the project, was taken and the model was tested . The test was carried out in the Ancient City of Aphrodisias as an applied model test, both due to the restrictions caused by covid-19 and in accordance with the main theme of the project. The test was conducted with E.YÜKSEL both with his own permission and with the approval of the Governor's Office.

4. Method

4.1. Obtaining the Data of the Ancient City of Aphrodisias

Google Earth Pro was used to obtain the data of the Ancient City of Aphrodisias. The Ancient City of Aphrodisias was scanned using the Google Earth Pro program and the Vector Information System (Figure 1). After scanning , a Google Earth Placemark File (KMZ) file containing features such as DEM data and elevation data of the Ancient City of Aphrodisias was created. Later , this file was converted to GPX (GPS eXchange Format) format by GPS Visualizer for use in ArcGis (ArcMap) program .

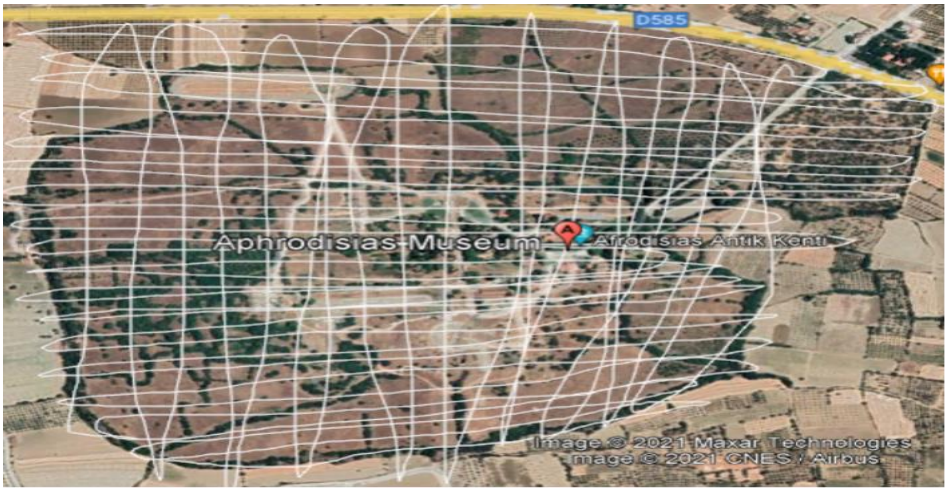

Figure 1. Scanning of the Ancient City of Aphrodisias with the Vector Information System

4.2. 2D Maps of the Ancient City of Aphrodisias

ArcGis (ArcMap) was learned to map the desired region. ArcGis (ArcMap) and Python were used.

4.2.1. Making 2D Maps Using ArcMap

The created GPX format file was saved to ArcMap program. Thanks to the IDW tool of the ArcMap program, the distribution and colored elevation map of the vector points was created. (Figure 2) ArcMap 's CONTOUR tool was used to create the isohips map. The elevation graph of the data points was created (Figure 3). The colored distribution map and the isohips map were combined (Figure 4). In addition to what was done, a relief map combined with the isohips map of the Ancient City of Aphrodisias was drawn (Figure 5). In order to see the frequency of elevation differences, isohips maps with 5 meters intervals and isohips maps with 10 meters intervals were compared (Figure 6).

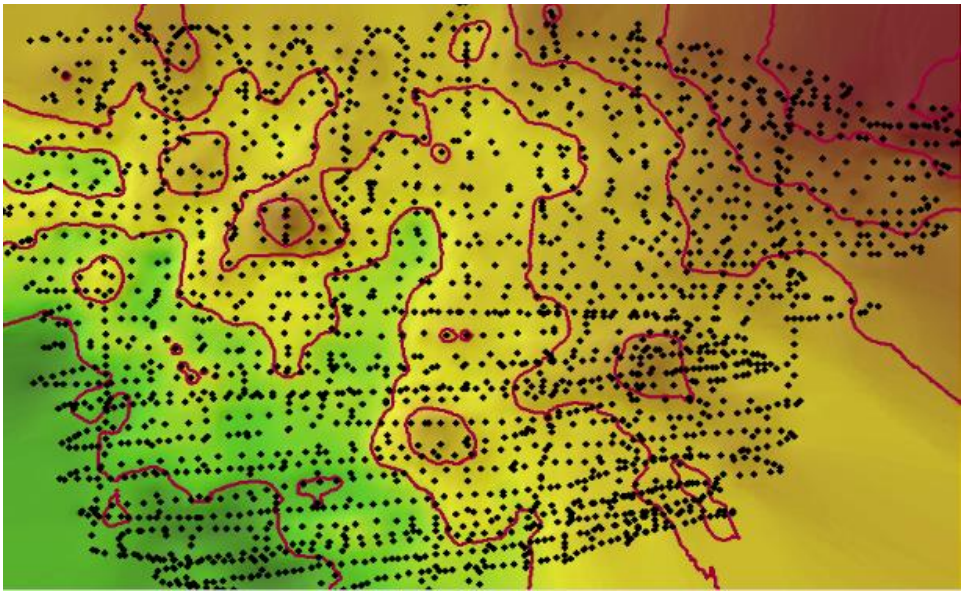

Figure 2. Distribution of Vector Points and Colorized Elevation Map

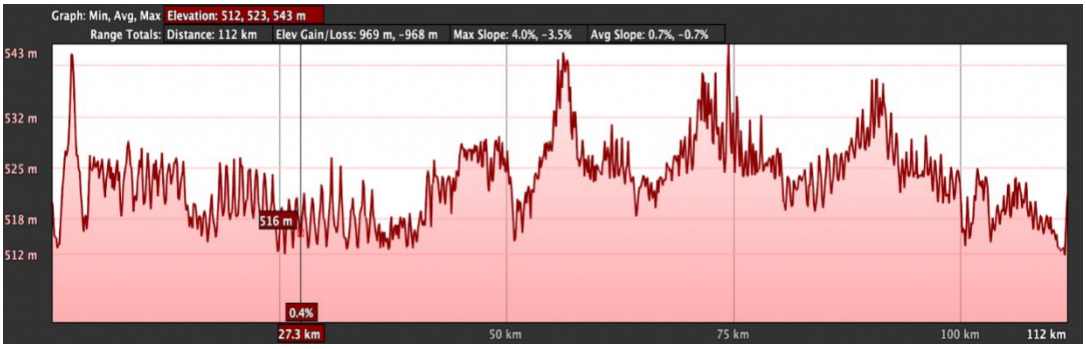

Figure 3. Elevation graph of the points taken from the Ancient City of Aphrodisias

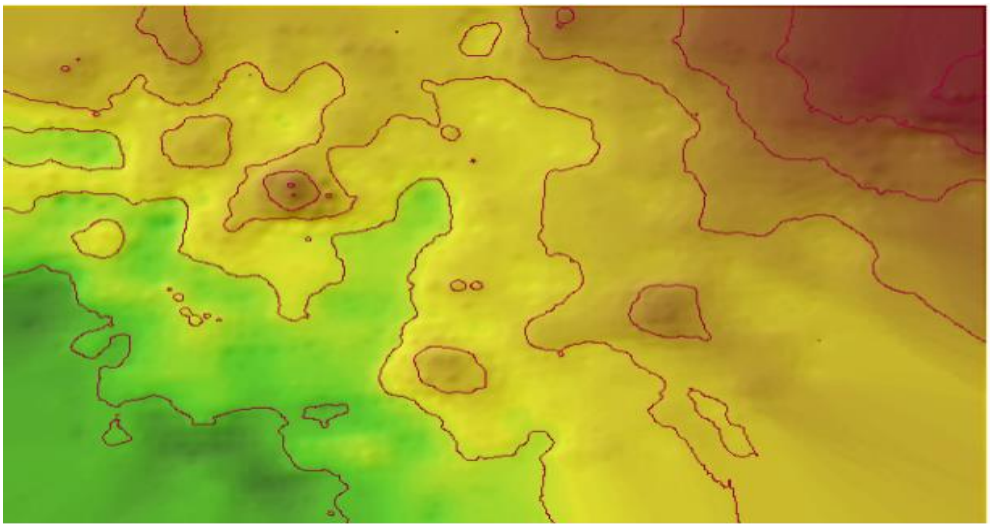

Figure 4. Colorized Elevation Map Combined with Izohips Map

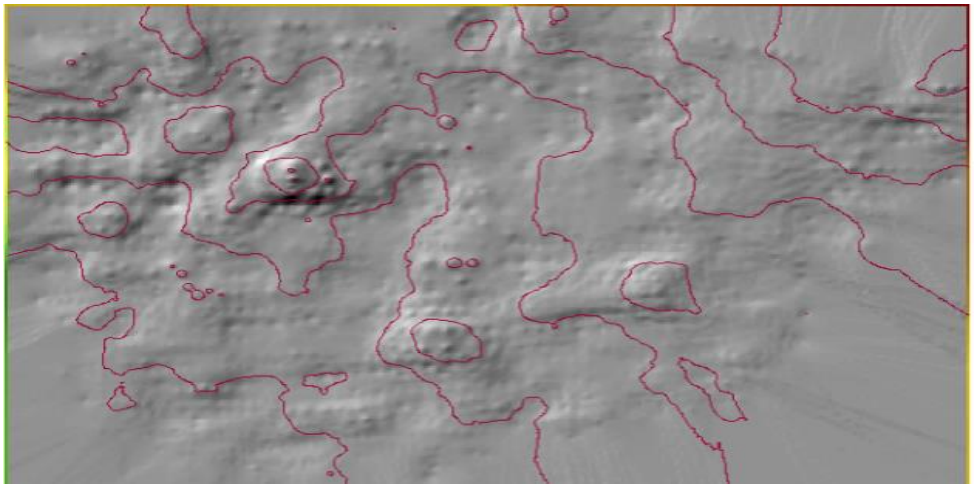

Figure 5. Relief Map Combined with Izohips Map

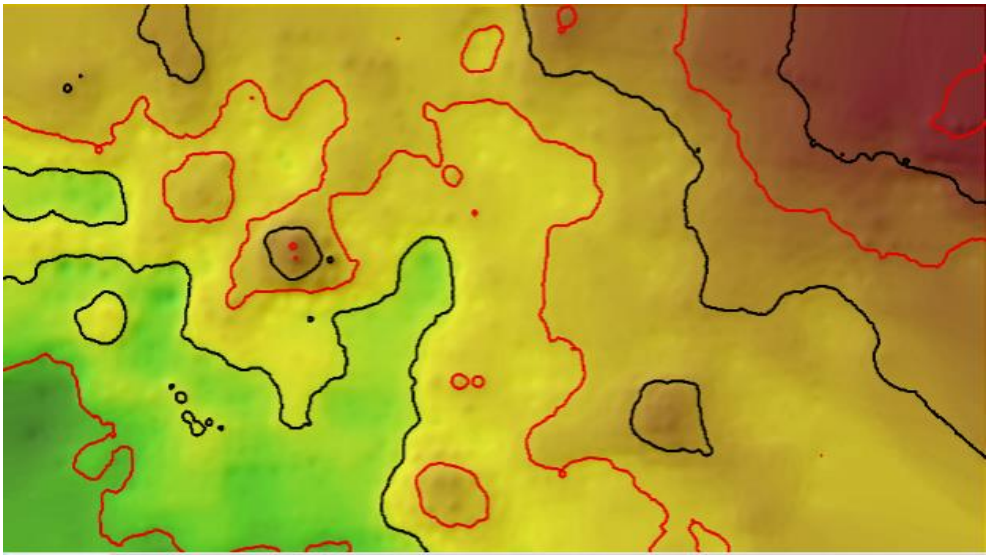

Figure 6. Comparison Map of 5 Meter Spaced Izohips and 10 Meter Spaced Izohips

4.2.2. Making 2D Maps Using Python

A photograph of the Ancient City of Aphrodisias was taken using the Google Earth Pro program (Figure 7). Later, the photo taken was converted into a tiff file, that is, it was converted to a high resolution image . Then, the codes that created the elevation map were written using python in the tiff file created (Figure 8 and Appendix 4). Codes that create a rather type map of the Ancient City of Aphrodisias were written using Python (Figure 9 and Appendix 4). The python libraries (numpy, matplotlib , geopandas) were used while creating the elevation map . Thanks to these libraries, information such as elevation information coordinates were obtained from the high resolution image created via Google Earth Pro.

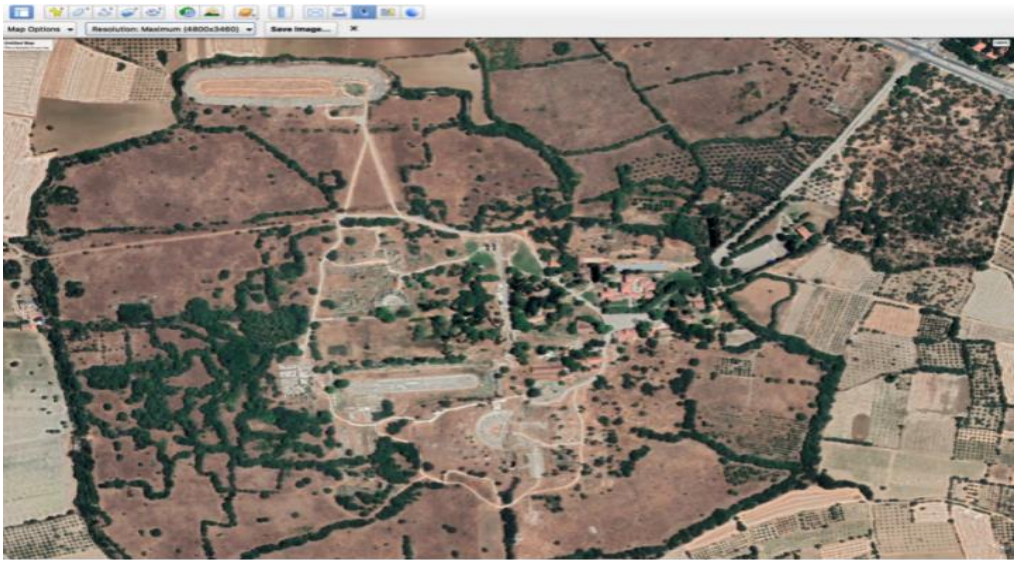

Figure 7. Photographing the Ancient City of Aphrodisias using Google Earth Pro

Get Started | afrodisiasson.py 3

Users > uygaregekocakir > Desktop > CografyaPython > afrodisiasson.py > ...

```
1   #IPythonun kütüphanelerini yüklüyoruz
2   import numpy as np
3   import matplotlib.pyplot as plt
4   import matplotlib.colors as colors
5   import geopandas as gpd
6   from pysheds.grid import Grid
7   import mplleaflet
8   #matplotlib inline
9   #Tiff dosyanın bilgisayardan çekilmesi ve yükselti haritasının oluşturulması
10  grid = Grid.from_raster('afrodisiasjpgson.tiff', data_name='dem')
11  #Plot fonksiyonu ile haritanın oluşturulması
12  def plotFigure(data, label, cmap='Blues'):
13      plt.figure(figsize=(12,10))
14      plt.imshow(data, extent=grid.extent)
15      plt.colorbar(label=label)
16      plt.grid()
17
18  elevDem=grid.dem[:-1,:-1]
19  plotFigure(elevDem, 'Yükseelti Haritası (m)')
20
21
```

Figure 8. Creating an Elevation Map of the Ancient City of Aphrodisias using Python

```
Users > uygaregekocakir > Desktop > CografyaPython > afrodisiasson.py > ...
1   #IPythonun kütüphanelerini yüklüyoruz
2   import numpy as np
3   import matplotlib.pyplot as plt
4   import matplotlib.colors as colors
5   import geopandas as gpd
6   from pysheds.grid import Grid
7   import mplleaflet
8   #matplotlib inline
9   #Tiff dosyanın bilgisayardan çekilmesi ve yükselti haritasının oluşturulması
10  grid = Grid.from_raster('afrodisiasjpgson.tiff', data_name='dem')
11  #Plot fonksiyonu ile haritanın oluşturulması
12
13  # Create a flow direction grid
14  #N    NE    E    SE    S    SW    W    NW
15  dirmap = (64,  128,  1,   2,    4,   8,    16,  32
16  grid.flowdir(data='inflated_dem', out_name='dir', dirmap=dirmap)
17  plotFigure(grid.dir,'Flow Direction','viridis')
18  # Specify discharge point
19  x, y = -107.91663,27.83479
20  # Delineate the catchment
21  grid.catchment(data='dir', x=x, y=y, dirmap=dirmap, out_name='catch',
22                 recursionlimit=15000, xytype='label', nodata_out=0)
23  # Clip the bounding box to the catchment
24  grid.clip_to('catch')
25  # Get a view of the catchment
26  demView = grid.view('dem', nodata=np.nan)
27  plotFigure(demView,'Elevation')
28  #export selected raster
29  grid.to_raster(demView, 'link')
30  # Define the stream network
31
32  grid.accumulation(data='catch', dirmap=dirmap, pad_inplace=False, out_name='acc')
33
34  accView = grid.view('acc', nodata=np.nan)
35  plotFigure(accView,"Cell Number",'PuRd')
```

dirmap: Any

Figure 9. Raster mapping of Aphrodisias Ancient City using Python

4.3. Creating a 3D Map of the Ancient City of Aphrodisias

ArcGis (ArcScene) program was used to create the 3D map of the Ancient City of Aphrodisias . The colored elevation map created by the ArcMap program was transferred to the ArcScene program. First, a 3D relief map of the Ancient City of Aphrodisias was created on ArcScene (Figure 10). Then, a colored elevation map was created (Figure 11).

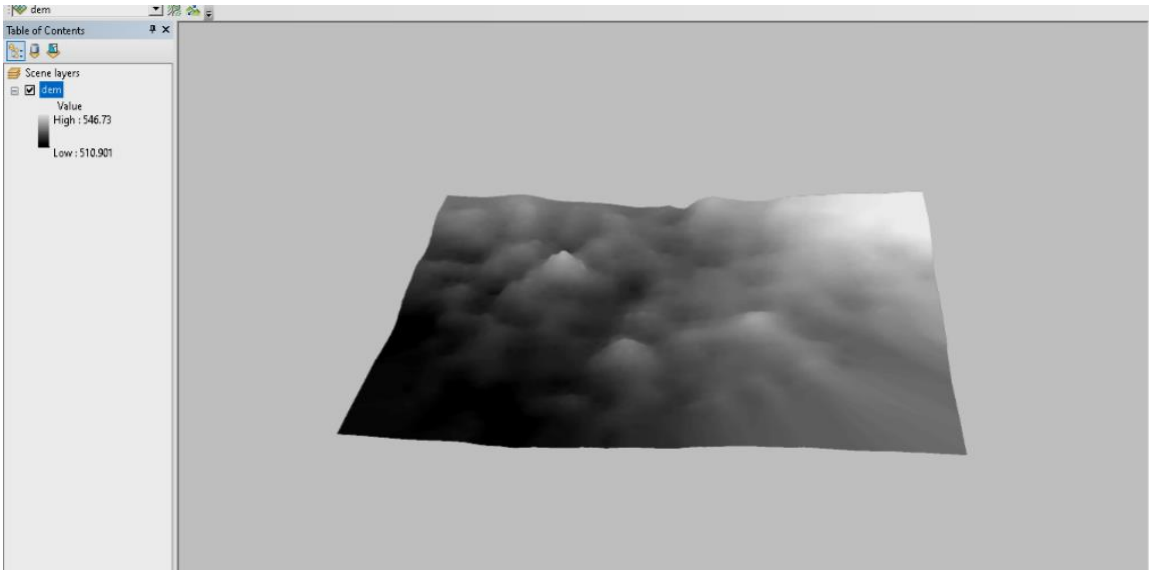

Figure 10. 3D Relief Map of the Ancient City of Aphrodisias

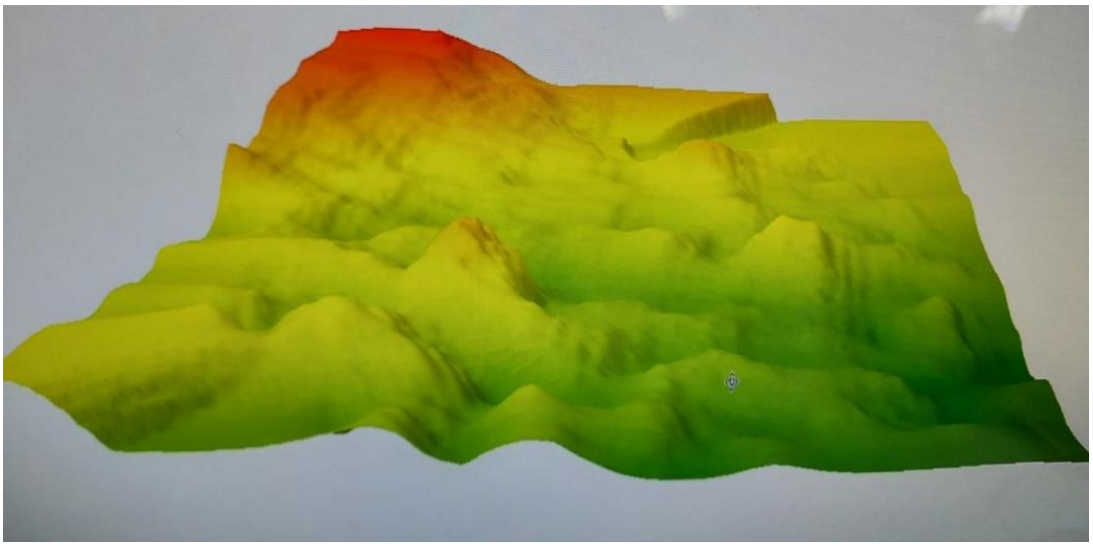

Figure 11. 3D Colorized Elevation Map of the Ancient City of Aphrodisias

4.4. Removing the 3D Model

Maps edited on ArcMap and Python were transferred to ArcScene to extract the 3D model . Details are arranged on the maps imported into ArcScene . After the details are edited, the file in Arcscene must first be WRL (Virtual Reality) to be output on the 3D printer. Modeling Language) has been translated into a file with the extension. Then, the WRL file was converted to STL (Stereolithography) file using the BLENDER application. The 3D model is arranged on the STL file (Figure 12). Finally, it was 3D printed using PLA+ material (Figure 13)

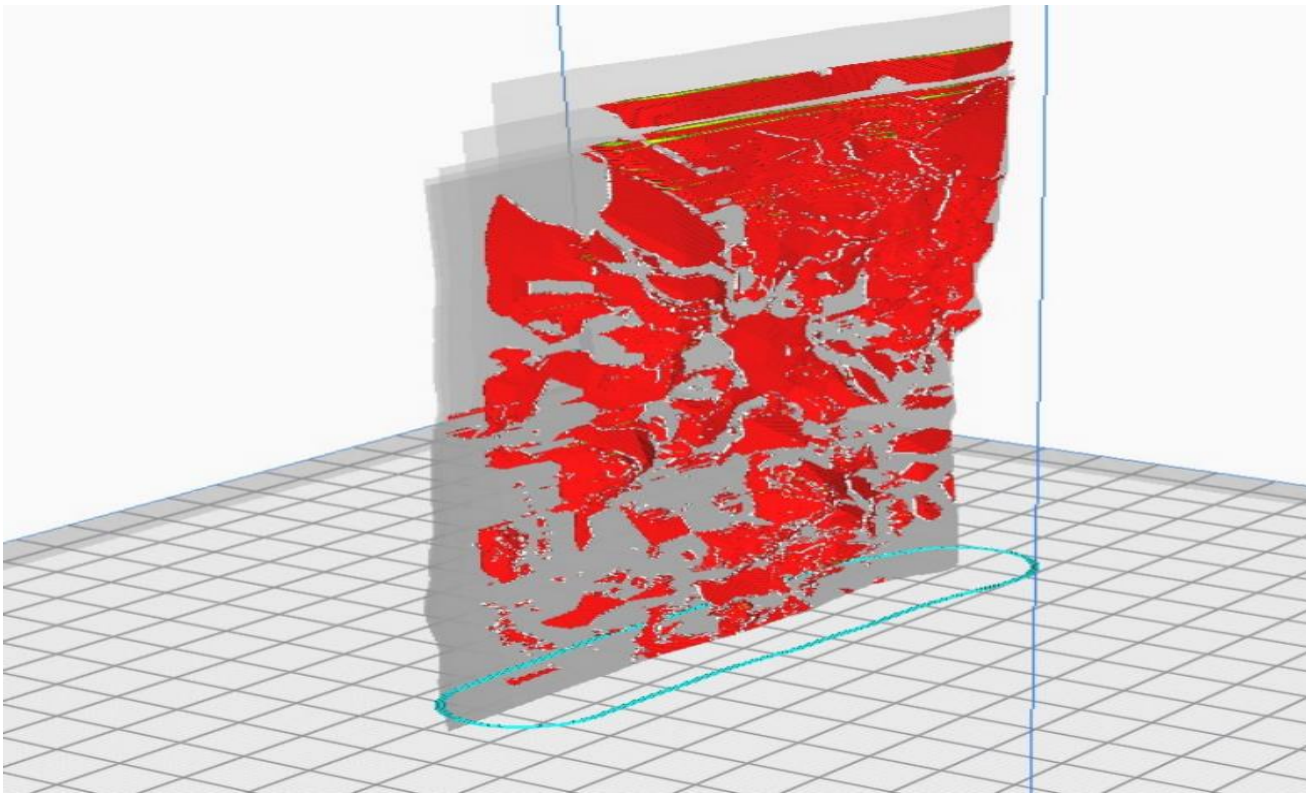

Figure 12. STL file of the 3D Map of the Ancient City of Aphrodisias

Figure 13. 3D Map of the Ancient City of Aphrodisias from a 3D Printer

4.5 . Testing the Model of the Ancient City of Aphrodisias

For the test of the project model, a voluntary visually impaired person was sought. During this search process, the Six Dots Association for the Blind was contacted on 12.01.2022. As a result of the communication established, an interview was made with the visually impaired E.YÜKSEL, who volunteered for the project test . In order to test the model for the Aphrodisias Ancient City to be visited, the Governor's Permit was obtained in cooperation with E.YÜKSEL (Annex 1 Figure 1). On 18.01.2022, the project team and E.YÜKSEL met with the Museum Director at the Aphrodisias Museum.Test trip A test route was determined to be visited on the city plan of the Ancient City of Aphrodisias before it took place (Figure 14). The test trip was carried out in the presence of the Museum Director (Figure 15). During the test trip, E.YÜKSEL's 3D map was in hand, and the project team and the Museum Director made observations, and the theater was first visited on the high point of the ancient city (Appendix 2, Figure 16). E.YÜKSEL listened to historical places with the help of a guide (Figure 16). E.YÜKSEL visited the pool and the ancient theater in the Ancient City of Aphrodisias with the help of a 3D map (Appendix 3, Figure 5). Afterwards, a visit was made to the bath area of the ancient city. After the Hadrian's bath tour, we went to the stadium of the ancient city of Aphrodisias . Later, the location of the stadium on the ancient city of Aphrodisias was determined (Figure 17). The same route as when returning (respectively sebasteion , theatre, pool, civil basilica , hadrian bath , northern agora, parliament building , sculpture school, Aphrodite Temple, Episcopal residence, stadium, tetrapylon and museum) were followed.

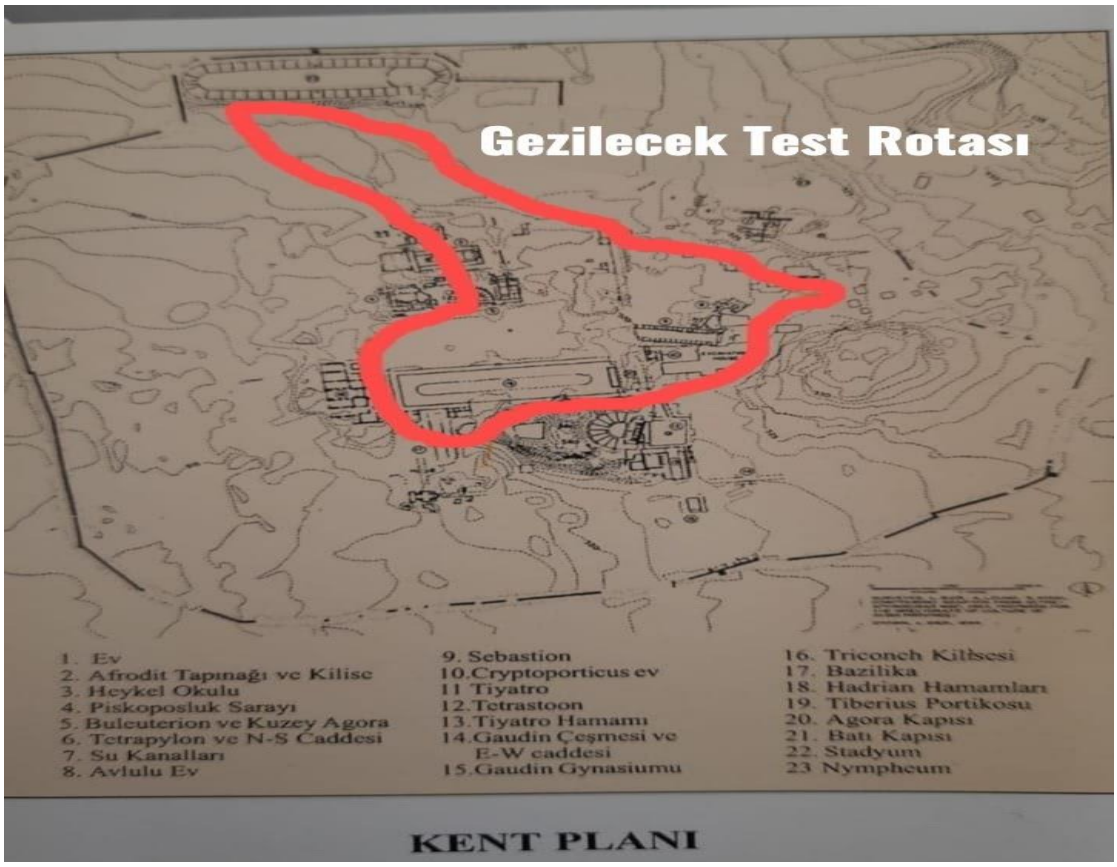

Figure 14. The test route drawn from the city plan of the Ancient City of Aphrodisias

Figure 15. Aphrodisias Antique City guide being tested by the guide , E.YÜKSEL from the model.

Figure 16. While the accuracy of the model is examines the Ancient Pool

Figure 17. The location of the stadium of the Ancient City of Aphrodisias on the 3D map

5. Project Work-Timeline

MONTHS							
Job	**August**	**September**	**October**	**November**	**December**	**Fireplace**	**February**
Literature Review	**x**	**x**	**x**	**x**	**x**	**x**	**x**
Field Study					**x**	**x**	
Data Collection and Analysis					**x**	**x**	**x**
Project Report Writing						**x**	**x**

6. Findings

A 3D map of the Ancient City of Aphrodisias was created with the help of the data obtained from the Google Earth program (Figure 18). The created 3D map was tested with a visually impaired individual, whose consent was obtained and who wanted to take part in this task. The student followed the map with the visually impaired individual (Figure 19). It was seen that

E.YÜKSEL was able to navigate the theater without any problems, using the map . E.YÜKSEL "As far as I understand from the map, there may be an elevation here." and warned the project team, who had never visited the museum (Figure 20). While visiting the bath area, which is located in a low area, E.YÜKSEL understood in advance that the area would descend thanks to the model, thus avoiding the danger of falling (Figure 21). E.YÜKSEL easily understood that it was a stadium with the shape of the stadium reflected on the map during his tour of the stadium and said that it was right in front of a flat land while sitting on the seats of the stadium (Figure 22).

Figure 18. 3D Map of the Ancient City of Aphrodisias

Figure 19. Student testing the model by following the map with the visually impaired

Figure 20. E. While making the HIGH elevation warning

Figure 21. E.YÜKSEL understands in advance that the region will descend, thanks to the model, while avoiding the danger of falling.

Figure 22. E.YÜKSEL while describing the elevation features in the Ancient City Stadium

Figure 23. E.YÜKSEL is talking about the landforms on the way back.

7. Conclusion and Discussion

- The elevation graph created by the information in Figure 1-2 was confirmed during our Aphrodisias trip.
- The data from Figure 1 and the map created with the help of the codes in Figure 8 were compared. As a result of the comparison, it was observed that the maps were similar to each other.
- During the Aphrodisias Ancient City tour, it was understood that the isohipps lines of the maps in Figure '4-6 are compatible with the landforms. It was seen that the isohips comparison in Figure 6 contributed to the visually impaired individual .

- As a result of the feedback of the visually impaired individual and the museum archaeologist, it was understood that there is a proportionality between the elevation map data in Figure 10 and Figure 11 created with the help of ArcScene and the 3D model in Figure 18.
  E.YÜKSEL visited the ancient city of Aphrodisias, reducing the difference between an individual who saw what the guide told with the 3D map in his hand (Appendix 3, Figure 3-15).
- In line with the feedback received from the visually impaired individual, it was understood that the isohipps lines on the maps in Figure 4-6 and the isohips lines on the maps in Figure 14 and Figure 19 matched.
- As a result of the fieldwork, the project, which aims to enable visually impaired individuals to visit the sites more efficiently and clearly, has come one step closer to its goal.
- easiest and most specific area to understand on the 3D model .

8. Suggestions

to visit, recognize and understand the historical sites without the need for the sense of sight they lack .

Thanks to the ever-developing technology , this project can be used to explain the topographic structure to the students more easily in the geography lesson, without the need for excursions, with the availability of 3D printers in schools.

In the military, it can be used to increase the performance of the operation in a more prepared way by providing a preliminary impression to the soldiers who do not know about that region.

Physical characteristics of the mountain, etc. in dangerous mountain climbing. It can be used to reduce deaths and injuries caused by not knowing exactly.
As can be understood from the feedback received from the disabled individual, Braille can be used on the map in the future stages of the project.

Resources

Bee, S. (2016). DESIGN OF WEARABLE DISTANCE METER USING HIGH FREQUENCY SOUND WAVES FOR THE VISUALLY DISABLED. Sakarya University /Institute of Science and Technology , Sakarya .

Access Address : h g (https://acikerisim.sakarya.edu.tr/bitstream/handle/20.500.12619/91143/T06557.pdf?sequence=1&isAllowed=y)

Bilge, B. (2017). ACCESSIBILITY IN HOUSING DESIGN FOR VISUALLY HANDICAPPED PEOPLE. *IJASOS-International E- journal of Advances in Social Sciences , 3* (7), 152-166. Access Address: (http://ijasos.ocerintjournals.org/en/download/article-file/298422)

Buyurgan, S. (2017). A living museum. *Journal of Creative Drama , 12* (2), 127-136.

Access Address: (https://dergipark.org.tr/en/download/article-file/1563630)

WHO IS VISUALLY DISABLED? (tb .). Edremit Municipality. Access Address: (What is 'Visually Impaired'? Who is 'Visually Impaired')

Kozan, H. I. Ö., Bozgeyikli , H., & Kesici, S. (2018). Barrier-free city: problems faced by visually impaired individuals in cities. *IDEALKENT , 9* (23), 216-235.

Access Address: (https://dergipark.org.tr/en/download/article-file/460190)

Şahin, K., & TURAN, BO (2018). COMPARATIVE ANALYSIS OF THREE-DIMENSIONAL PRINTING TECHNOLOGIES. *Journal of Strategic and Social Studies , 2* (2), 97-116.

(https://dergipark.org.tr/en/download/article-file/520890)

TANRIKULU, M. (2010). Teaching map information to 9th grade visually impaired students studying in mainstreaming environments. Teaching map information to 9th grade visually impaired students studying in mainstreaming environments. *Turkish Journal of Social Research* , *153* (153). (https://dergipark.org.tr/en/download/article-file/200475)

Uçar, D., & Doğru, A. Ö. (2005). Strategic Planning of GIS Projects and Place of Swot Analysis. TMMOB Chamber of Surveying and Cadastre Engineers, 10.

AccessAddress:(https://web.itu.edu.tr/~doruahm/D%20Ucar_CBS%20Projects%20Strategic%20Planlamasi%20Ve%20Swot%20Analysis%20Yeri.pdf)

Vulga, S. (2020). SYSTEM DESIGN FOR THE TRANSMISSION OF INFORMATION THROUGH THE SKIN TO THE HEARING AND VIRTUAL HANDICAPPED PEOPLE. Baskent University/Institute of Science and Technology, Ankara.

Access Address:(https://acikbilim.yok.gov.tr/bitstream/handle/20.50012812/66627/yokAcikBilim_10322697.pdf?sequence=-1&isAllowed=y)

Yesilyurt, H., KIRLAR, B., & Ceyda, LALE (2014). THE SILENT AND DARK WORLD OF MUSEUMS: IS "MUSEUMS FOR EVERYONE" POSSIBLE ?. *Journal of Gazi University Faculty of Tourism* , (2), 1-19.

Access Address: (https://dergipark.org.tr/tr/download/article-file/811698)

Yusuf, GEN C. (2016). Social problems and expectations of the disabled. *Journal of Social Policy Studies* , (35/2).

Access Address: (https://dergipark.org.tr/en/download/article-file/198291)