A Journey to Salamis Island (Greece) using a GIS Tailored Interactive Story Map Application

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Abstract: Web GIS applications have been used to communicate and showcase spatial information to the general public. In the demonstrated Web GIS application, the aim was to highlight the importance of a historic area, Salamis island (Greece), through its natural and anthropogenic environment using narrative text, multimedia, and web content as well as geospatial data and 3D visualization. Using StoryMaps, a widespread geographical visualization approach, used for science and spatial data communication, information, education, and dissemination, new functions combining many scientific fields were integrated, producing an interactive responsive web app in such a way that scientific knowledge can be received and comprehended by a broader audience.

1 INTRODUCTION

Geographic Information Systems (GIS) technologies can provide new opportunities for immersive content while widely engaging public audiences with complex multivariate datasets. One of their latest accomplishments is story maps which can provide support for scientific storytelling compellingly and straightforwardly (Antoniou, et al., 2019a) using multi-media content and narrative text for visualizing spatial data effectively. Thereby, Story Maps can be used to disseminate and understand scientific findings to broader non-technical audiences (Janicki et al., 2016; Wright et al., 2014).

In this paper, an effort has been made to present history (archaeological sites, monuments), biodiversity (unique flora and fauna), geodiversity (geomorphology, geological formations, sea-level changes, land cover), and cultural and recreation areas for Salamis Island (Greece) through a narrative interactive story map.

2 STUDY AREA

Salamis island is the largest island of the north Saronic gulf and is located close to the Attica coastline. Having a coastline that reaches 100 km in length, it features tens of bays, peninsulas, capes, bays, beaches, and small islands (Fig. 1).

The island of Salamis consists of low elevation hills and small valleys in an approximately east-west direction. Salamis has been delimited by sea-level changes, forming an island or a land connected with the Attica peninsula.

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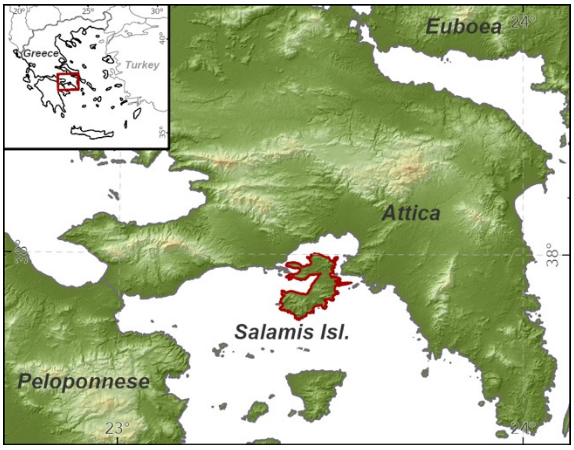

Figure 1: Geographic location of Salamis Island.

During the Pleistocene period, the straits that separate Salamis Island and Attica, were sometimes navigable while at other times one could cross them on foot. Alpine and post alpine geological formations, consisting mainly of carbonate rocks, ophiolites, and alluvium respectively, form the geological structure of Salamis. Fault zones have formed the characteristic shape of the island. Salamis is an island that has been inhabited non-stop, since the Mycenaean Era. Its name is associated with the naval battle of Salamis in 480 BC, between the Persian fleet and the city-states of the Greeks. It is an island filled with historical monuments, many of which have had different uses over the centuries.

3 METHODOLOGY

To meet the challenge of creating the Story Map of Salamis Journey, which focuses on presenting the natural as well as the anthropogenic environment of the island in combination with its historical value, different types of datasets have been compiled, either new ones or from open-source portals. New ones were collected during multiple data collection field trips, aiming to capture geolocated photos and videos for each site of interest to enrich the existing geo-cultural knowledge.

Salamis Journey has been created using the ArcGIS platform (Esri), although other software (free or commercial) is also available (e.g., StoryMapJ[1], Google Earth Outreach[2], TimeMapper[3], Odyssey by CARTODB[4], thinglink[5]). After sorting out the outdated software, the selection was based firstly on the fact that all available data could be processed in the chosen platform. Additionally, all the necessary tools and apps exist in this platform without the need to use different software to achieve the same result and without the need for programming. Lastly, the research team has previous related experience with this platform (e.g., Antoniou et al., 2018a, 2018b, 2019a, 2019b, 2020a).

Thus, all the available vector and grid spatial data, along with descriptive ones, were first collected, homogenized, and organized into a geodatabase via ArcGIS Pro[6] v.2.6 software. Moreover, the geodatabase also contained the necessary feature layers to be used during fieldwork. ArcGIS Collector[7], an application available in web and mobile version (for Android and iOS devices, tablets, or smartphones) through the ArcGIS platform was used to ensure the accuracy of the geographic location of the sites of interest and to collect and update real-time, spatial and descriptive data. Using a webmap, created and shared via ArcGIS Pro, which contained the feature classes devoted to data collection, points that correspond to sites of interest were collected using the map or the GPS signal, while descriptive text and photos or videos completed the fields available in the attribute table of the corresponding layer as attachments. After sharing all available information layers to ArcGIS Online[8], 2D and 3D webmaps (scenes) were created.

Furthermore, to enhance the interactivity of the story map, a 3D representation of specific sites of cultural interest was implemented. Firstly, a 3D representation of the two museums operating on the island was created. The building footprints were converted to multipatch features and then extruded to the buildings' actual height. The features' vertices were then edited to more accurately and realistically visualize their architectural features. Finally, facade and rooftop textures were added to the buildings, using photos obtained from the field trips. Due to some building sides being partly blocked by other structures, photos of other facades were used to imitate their actual texture. The photos were edited, cropped, and rectified to be sharp and best fit each

[1] https://storymap.knightlab.com
[2] https://www.google.com/earth/outreach/
[3] http://timemapper.okfnlabs.org/
[4] https://cartodb.github.io/odyssey.js/
[5] https://www.thinglink.com/
[6] https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview
[7] https://www.esri.com/en-us/arcgis/products/arcgis-collector/overview
[8] https://www.esri.com/en-us/arcgis/products/arcgis-online/overview

side of the multipatch features. The outcomes were then used to produce 3D webmaps (scenes).

Secondly, for the generation of detailed 3D photorealistic models of two selected cultural heritage landmarks, a field photogrammetric survey was carried out. Highly overlapping vertical and oblique images were taken using a DJI Phantom 4 Pro drone. Ground control points (GCPs) were also measured with GPS-RTK for establishing scale and accurate geolocation of the 3D models. Textured 3D mesh models were created through standard Structure from Motion (SfM) workflows and synthetic fly-through videos were rendered to showcase the obtained results. The models were uploaded to an online 3D viewer sharing app (Sketchfab[9]) to offer users the possibility to interact with the reconstructed spaces in 3D or Virtual Reality (VR) and then embedded in the StoryMap.

An appropriate template for the StoryMap had to be selected, after having gathered and processed all the data for Salamis island. Esri provides several configured apps[10] using open source as well as a new StoryMap template combining popular features from the previously mentioned ones, which can be used either as they are (or with minor CSS code modifications in ArcGIS Assistant[11]) through ArcGIS Online or can be downloaded through GitHub, modified and then served through a private server (Antoniou & Vassilakis, 2019). The first approach was followed during the deployment of this StoryMap, not only due to the large number of users expected to visit the application but also due to the lack of a private server capable of managing them.

As far as the visual output is concerned, the new story map approach called ArcGIS StoryMaps[12] was implemented, as it features a user-friendly interface having, at the same time a responsive design and enhanced capabilities to incorporate 3D visualization. Also, the ArcGIS StoryMaps template has many important accessibility functions to support readers with impaired vision or limited mobility, which have been utilized. Furthermore, due to the large variety of multiple information that needs to be presented, we used the guided linear narration through immersive scrolling (Antoniou et al., 2020) as it is more effective for the users than the one that allows jumping from one tab to another without sequence (Antoniou et al., 2018a).

Finally, the ArcGIS StoryMaps builder accessed also through a free, non-commercial ArcGIS public account, was used to combine narrative text with scenes, images, and multimedia as well as web content in an engaging, full-screen scrolling experience, as described in the following chapter.

4 THE STORY MAP

In the created StoryMap, all the geocultural, ecological, and tourism data for the historical island of Salamis[13], were presented using 2D and 3D webmaps (scenes), narrative text, images, multimedia, and web content, as well as 3D models. The thematic maps of the application were created either in ArcGIS Pro or directly in the ArcGIS Online platform, based on the collected data, fieldwork, and literature review, depicting the most impressive points of interest. The individual parameters for each of the information layers, e.g., its symbol, the appearance or not of pop-up menus, reference scale, etc., have been determined (DiBiase et al. 1992; Newman et al. 2010).

All available information was grouped into six sections covering (a) the general information of the natural and anthropogenic environment of the island, (b) its geodiversity, (c) its biodiversity, cultural information concerning Historical monuments (e) and Archaeological sites (f) and (g) recreation and outdoor activities. The different sections were separated using a representative photo or video.

A user's first impression upon entering the interactive application is a representative photo of the area showing the monument dedicated to the famous naval battle of Salamis (Fig. 2), while a button allowing the change of the display language is also present. At this moment, the StoryMap is presented in the Greek text, but efforts are already underway to translate it to English.

The narration starts with a brief presentation of the main natural and anthropogenic features of the island that made it famous, while a video gives a glance of Salamis Island in time and space. The narrative text proceeds to provide information about the geographic location of the island, as well as about its morphology, while an interactive scene was created to present the available information. A 5-m-resolution digital elevation model from the National Cadastre & Mapping Agency S.A. of Greece rendered according to elevation, as well as a multidirectional shaded relief was used to represent the morphology upon a

[9] https://sketchfab.com/
[10] https://storymaps-classic.arcgis.com/en/app-list/
[11] https://ago-assistant.esri.com/
[12] https://storymaps.arcgis.com/
[13] https://arcg.is/jXqDD

light, neutral background basemap with minimal colors, labels, and features, named Light Gray Canvas. Drainage network in parallel with the main settlements and specific locations (e.g., mountain names, islands around the area) mentioned in the text complete the scene. Users can use the tools at the bottom right of the map, to zoom in and out or right-click anywhere on the scene to tilt and rotate to view the scene from different points of view (Fig. 3a), a functionality available in all 3D map frames included in this application.

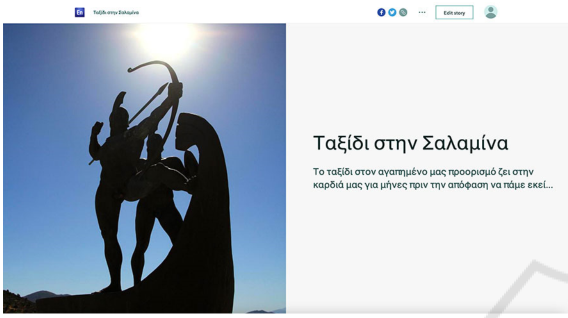

Figure 2: Screenshot showing the home page of Salamis Island StoryMap. In the upper left part, users can select a different language for the narration.

18.000 years ago, Salamis was a part of the Attica region, connected also with the other present islands of the Saronic Gulf, and its morphology was altered because of the constant upward movement of the sea level. To demonstrate this movement and enhance the narration, a video animation, in MP4 format was created in ArcGIS Pro, being a combination of successive thumbnails of the spatial distribution of appropriate feature layers along with two digital elevation models, one for onshore areas with pixel size 25 m and one for offshore, provided by EMODnet[14] with 1/16 * 1/16 arc minutes resolution. Keeping the present days' coastline steady, we defined the sea level boundary in two well-known critical moments (Lambeck et al., 2014), 18.000 and 11.000 years ago (Fig. 3b).

The anthropogenic environment of the island in present days is also presented based on the CORINE Land Cover [15] 2018 classification. Also, using a topographic map by Curtius, Ernst. and Kaupert, Johann A. (Curtius & Kaupert,1895-1903), a land cover feature class was created for the island's area in 1895. These two datasets along with the shaded relief of the island upon a neutral background basemap with minimal colors, labels, and features, named Dark Grey Canvas, were combined to create firstly two separated webmaps and secondly a Swipe media, to demonstrate landcover changes between these two different periods, 1895 and 2018. The user can swipe left or right with the interactive slider to see how the spatial distribution of each land cover category changed over the last roughly 125 years (Fig. 4). This functionality, in combination with pop-up menus, provides additional information, making the prevalence of the urban fabric in recent years evident.

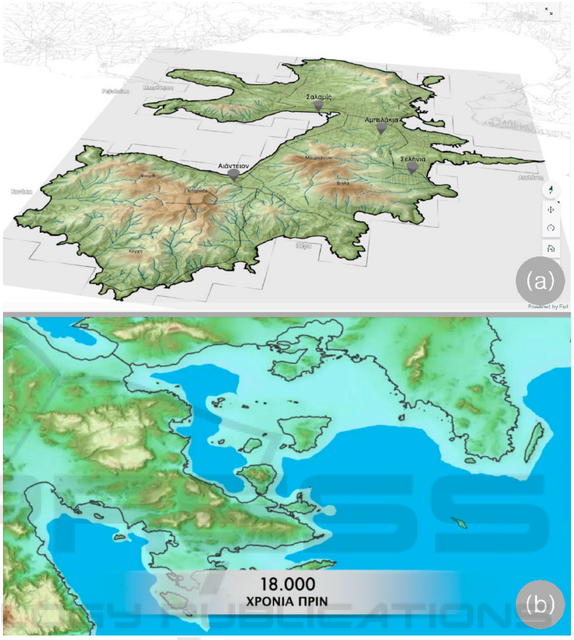

Figure 3: Screenshots showing (a) the scene created to present the morphology of the area and (b) the animation video presenting the sea-level changes from 18.000 up to present days.

The first section concludes with a narrative overview of the archaeological research done on the island, starting from 1883 when Schliemann researched the islets in the northern part of the Strait of Salamis until present days with the collaboration between the Institute and the Tax Office of Underwater Antiquities documenting the ancient port facilities in Ampelakia bay.

The second section presents the geodiversity of the island consisting of the geological – tectonic structure which is demonstrated in three-dimensions along with the shaded relief of the island upon a Light Grey Canvas basemap using a scene (Fig. 5). Due to their complexity and the absence of specialized knowledge of geology by the general public,

[14] https://www.emodnet-bathymetry.eu/

[15] https://land.copernicus.eu/pan-european/corine-land-cover

geological formations are grouped into two main categories: alpine and post- alpine.

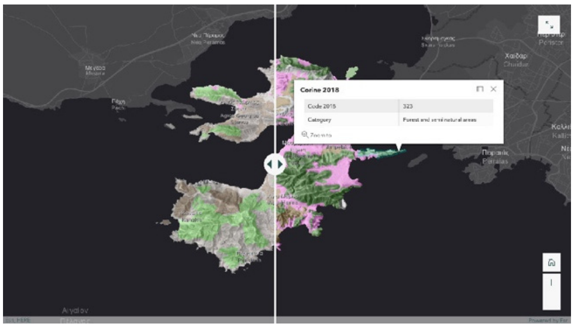

Figure 4: Screenshot showing the Swipe media used to compare changes in land cover over two time periods, 1895 (left webmap) and 2018 (right webmap). Through pop-ups, users can extract more information.

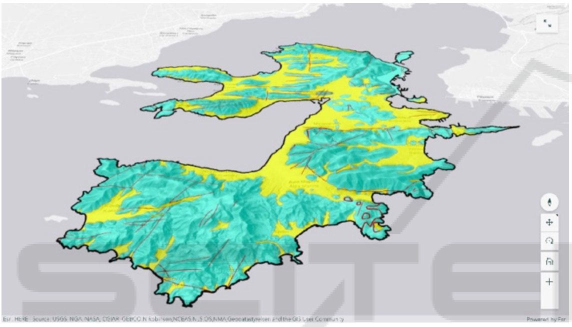

Figure 5: Screenshot showing the spatial distribution of geological formations grouped in two main categories: alpine (green color) and post-alpine ones (yellow color). Faults are also presented as line red-colored features.

Although Salamis island is covered mainly by alpine formations (green color) a narrative text presents the main characteristics of the geological formations of each category as well as its tectonic structure. Alpine formations are separated into two main geotectonic units: (a) the Sub-Pelagonian one, which represents the tectonic basement of the island, and consists mainly of neritic limestone, ophiolites, and a shale-chert-sandstone formation (Tataris, 1997), and (b) the overthrusted Eastern Greece Unit at the northern part of the island, consisting mainly of limestone, which forms the characteristic landforms of the area. On the other hand, post alpine formations overlay in unconformity on the alpine ones differentiated in two phases: (a) the marly limestone, marls, sandstone, and conglomerates deposited in the marine environment and (b) the terrestrial formations consist of slope debris, debris, conglomerate, and alluvial deposits. The peculiar morphology of Salamis island is the result of the different geological formations combined with faults which create local morphological variations and despite intense urbanization are still visible to the visitor.

The third section presents the biodiversity and ecosystems of the area through narrative text and representative photos. The island belongs to the Euro-Mediterranean vegetation zone, presenting typically Mediterranean vegetation species, such as Aleppo pine that form four forest areas (Fig. 6a) further described in the text. Additionally, more info (photos and text) regarding the species of flora and fauna of the forests, hills, and coasts of the island, presented through immersive Slideshows (Fig. 6b).

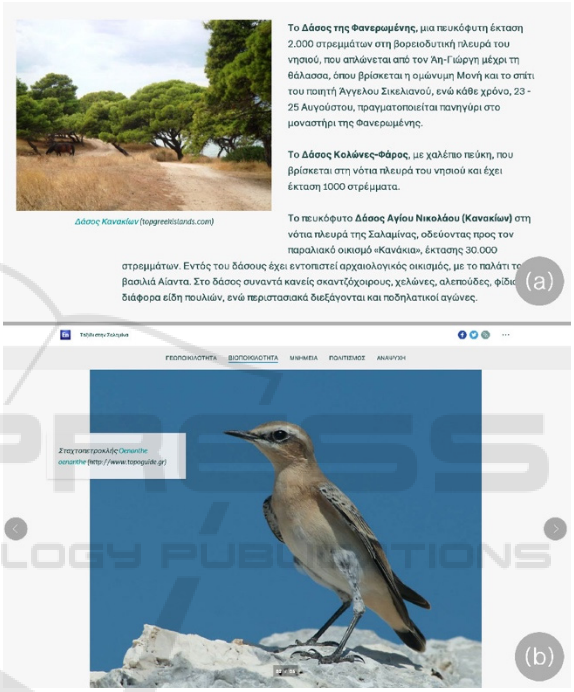

Figure 6: Screenshots showing (a) the narrative text describing the main forest areas of the island while a representative photo of one of them enhances the narration and (b) the immersive Slideshow created to present representative photos of fauna.

The narration of the fourth section starts by presenting the historical information about significant personalities of Ancient Greece, born or having lived on the island e.g., Euripides and Ajax the Great, as well as about the famous naval battle of Salamis. Three presentation ways were chosen for the important archaeological sites of the island. Firstly, a 3D representation of the Archaeological museum as well as of the Folk and Maritime Museum of Salamis was created (Fig. 7a) using the 3D model of the building produced through a multipatch features technique upon a 3D representation of satellite imagery basemap. The supplementary text outlines the buildings' main activities and exhibits.

After that, photogrammetric computer vision was used to create a 3D model of one of the most important monuments named "Circular burial monument", while the narrative text describes its importance (Fig 7b). For the image-based 3D reconstruction of the monument, vertical and oblique photos from a drone survey were combined with GPS measurements. Open-source tools AliceVision & Meshroom (Jancosek and Pajdla, 2011; Moulon et al., 2012) were employed for Structure-from-Motion. Typically, scale-invariant feature transform (SIFT features) and their corresponding descriptors (Lowe, 2004) are extracted on the available imagery and matched across different viewpoints. At this stage, all available GCPs are identified and measured on the images. An incremental pose estimation algorithm is followed by a self-calibrating bundle-adjustment solution to optimally estimate the interior orientation of the drone's camera and the exterior orientation of each view. A sparse 3D reconstruction is also estimated through the triangulation of all feature matches. A dense point cloud is then obtained through multi-view dense stereo algorithms and a mesh model is computed through 3D triangulation of the point cloud. The photorealistic texture is applied through a multi-view blending scheme. The final 3D model was simplified, uploaded to Sketchfab online 3D viewer, and embedded in the StoryMap. The users can interact with the embedded 3D model, rotating, zooming, and tilting it, while a VR option is active.

Other places of interest, including also modern and religious monuments, are presented through a guided immersive, media-focused, Map Tour where users can scroll through them in sequential order (Fig 7c). Representative photos, as well as narrative text for each place, frame the location of each area upon a satellite imagery webmap.

A second photogrammetric 3D reconstruction was performed for the lighthouse of the island, following the same workflow described above. The obtained 3D model offers users the possibility to interact with it and gain further knowledge by reading the description in the text (Fig. 8a).

All the other places mentioned, are presented through a guided immersive, map focused, Map Tour where users can scroll through them in sequential order (Fig 8b). Users navigate from place to place either by following the list of places or jumping from one place to the other, by choosing a point on the map. Representative photos and narrative text frame each point's location on a satellite imagery webmap.

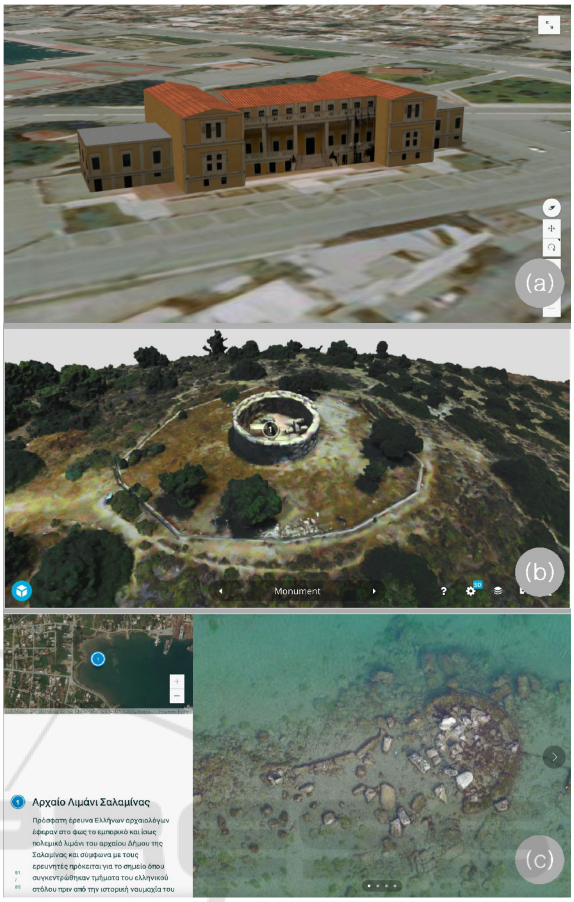

Figure 7: Screenshots showing the three different ways used to represent the archaeological, modern, and religious monuments. (a) 3D representation of the Folk and Maritime Museum of Salamis using multipatch features technique in a satellite imagery scene, (b) 3D model of "Circular burial monument" using SfM technique, and (c) a media-focused guided tour.

The last section is dedicated to the outdoor activities on the island. Walking paths, cycling routes, and scuba diving spots, an immersive Sidecar with a docked panel is used to present the available information. For walking paths, narrative text and photos give information about each path, while a scene highlights its trail upon satellite imagery. Using the bullets on the left side of the Sidecar, users can jump from one path to the other (Fig. 9a). Cycling routes are presented by a representative photo and corresponding text while in the diving section, scuba diving possibilities are presented through a text-multimedia content combination, accompanied by the diving spots around it, presented in a satellite imagery webmap (Fig. 9b). For fishing shelters and bathing waters, a map focused Map Tour has been chosen.

At the end of the StoryMap, all references that were used, are properly cited, along with the research team responsible for its creation.

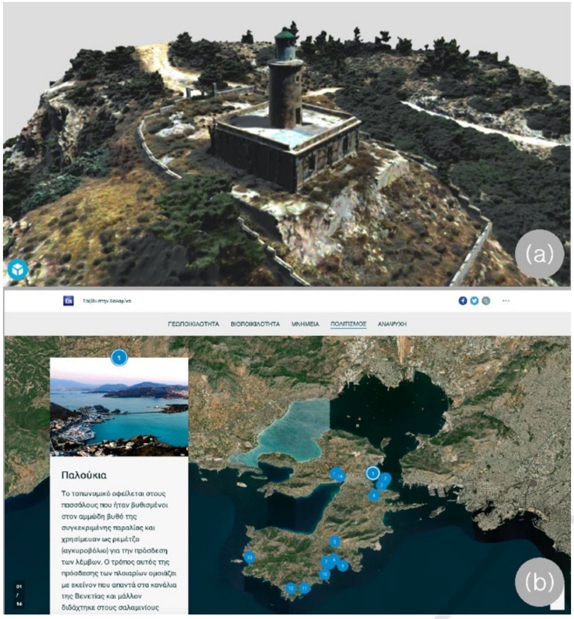

Figure 8: Screenshots showing the two different ways used to present the cultural heritage and touristic information: (a) a 3D model of the island's lighthouse using the SfM technique, (b) a map focused on a guided tour for the places of interest.

5 DISCUSSION

Web GIS applications have been used to communicate and showcase spatial information to the general public. As is true with all online content, their functionality and usefulness are made even more evident during the current Covid-19 pandemic (e.g., Antoniou et al., 2020c). Esri's StoryMaps in particular, have aided in disseminating data and information to all those concerned in a visually compelling and engaging manner, as shown in examples used to promote archaeology (e.g., Malinverni et al., 2019; Alemy et al., 2017), as well as ones aiming to enhance the education process (Kallaher et al., 2017; Cope at al., 2018).

In the demonstrated GIS application, the aim was to highlight the importance of a historic area through its natural and anthropogenic environment using narrative text, multimedia, and web content as well as geospatial data and 3D visualization.

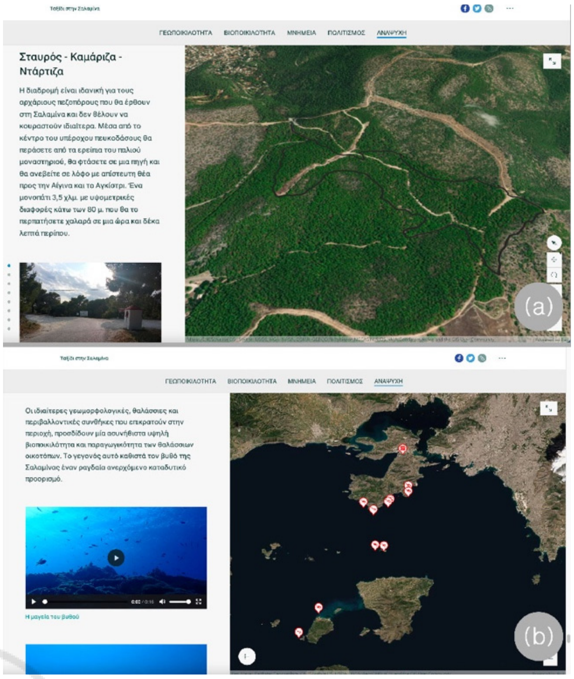

Figure 9: Screenshots showing (a) the presentation of walking path trails using text, photos, and a scene and (b) scuba diving spots around the island along with descriptive text and multimedia content.

Using StoryMaps, a geographical visualization approach, which provides many possibilities, due to the simplicity of use, both from the aspect of the developer and the end-user, we manage to integrate new functions combining many scientific fields and produce an interactive responsive web app in such a way that scientific knowledge can be received and comprehended by a broader audience.

The developed application has already reached several users in a very small period, and we expect to broader the audience since it is shared through Salamis Municipality and Regional Governor of Attica websites.

Finally, as Salamis Island is adjacent to the Attica peninsula, it has a recognizable historical identity that the audience can easily access through this application. Furthermore, the user can navigate through the natural, historical and contemporary environment of the Island. Visiting the Island in this manner, the audience has a strong motivation for a future in situ exploration.

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EMODnet Digital Bathymetry (DTM) http://doi.org/10.12770/18ff0d48-b203-4a65-94a9-5fd8b0ec35f6 was used.

REFERENCES

Alemy, A., Hudzik, S., Matthews, C.N., 2017. Creating a User-Friendly Interactive Interpretive Resource with ESRI's ArcGIS Story Map Program. *Hist Arch* 51**,** 288–297. https://doi.org/10.1007/s41636-017-0013-7

Antoniou, V., Nomikou, P., Bardouli, P., Lampridou, D., Ioannou, Th., Kalisperakis, I., Stentoumis, Ch., Whitworth, M., Krokos, M., Ragia, L., 2018a. An Interactive Story Map for the Methana Volcanic Peninsula. *4th Int. Conf. on Geographical Information Systems Theory, Applications and Management* GISTAM 2018, 68-78, ISBN: 978-989-758-294-3.

Antoniou, V., Ragia, L., Nomikou, P., Bardouli, P., Lampridou, D., Ioannou, T., Kalisperakis, I. Stentoumis, C., 2018b. Creating a Story Map Using Geographic Information Systems to Explore Geomorphology and History of Methana Peninsula. *ISPRS Int. J. Geo-Inf.*, *7*, 484.

Antoniou, V., Nomikou, P., Bardouli, P., Sorotou, P., Bonali, F.L., Ragia, L. and Metaxas, A., 2019a. The Story Map for Metaxa Mine (Santorini, Greece): A Unique Site Where History and Volcanology Meet Each Other. *5th Int. Conf. on Geographical Information Systems Theory, Applications and Management* GISTAM, 212-219.

Antoniou, V., Nomikou, P., Zafeirakopoulou, E., Bardouli, P., Ioannou, T., 2019b. Geo-biodiversity and cultural environment of Nisyros volcano. *15th Int. Congress of the Geological Society of Greece*, Sp. Pub. 7 Ext. Abs. GSG2019-195, Athens, 22-24 May 2019, p. 716-717.

Antoniou, V. and Vassilakis, E., 2019c. Diffusion of Geo-Environmental Datasets through Online Interactive and Real-Time Applications. Case Study: The Natura GR2440006 Protected Area. *Annals of Geographical Studies*, 2, 1, 8-16.

Antoniou, V., Nomikou, P., Papaspyropoulos, K., Zafeirakopoulou, E., Vlasopoulos, O., Xrysopoulou E.V., Tziannou, E., Ragia, E., 2020a. Corinth Gulf Story Map: Enhancing Public Awareness in Natural and Anthropogenic Environment using Interactive GIS Applications. *6th Int. Conf. on Geographical Information Systems Theory, Applications and Management* GISTAM 2020, 262-269.

Antoniou, V., Vassilakis, E., Hatzaki, M., 2020b. Is Crowdsourcing a Reliable Method for Mass Data Acquisition? The Case of COVID-19 Spread in Greece During Spring 2020. *ISPRS Int. J. Geo-Inf.*, *9*, 605.

Cope, M.P.; Mikhailova, E.A.; Post, C.J.; Schlautman, M.A.; Carbajales-Dale, P., 2018. Developing and Evaluating an ESRI Story Map as an Educational Tool. *Nat. Sci. Educ.* 2018, *47*, 180008, doi:10.4195/nse2018.04.0008.

Curtius, E., Kaupert, J.A., 1895-1903. Karten von Attika. Berlin. https://doi.org/10.11588/diglit.776

DiBiase, D., MacEachren, A.M., Krygier, J.B. and Reeves, C., 1992. "Animation and the Role of Map Design in Scientific Visualization". *Cartography and Geographic Information Systems*, 19 (4): 201–2014.

Janicki, J., Narula, N., Ziegler, M., Guénard, B., Economo, E., 2016. Visualizing and interacting with large-volume biodiversity data using client–server web-mapping applications: The design and implementation of antmaps.org. *Ecological Informatics*, 32, pp.185-193.

Jancosek, M., Pajdla, T., 2011. Multi-view reconstruction preserving weakly-supported surfaces. *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognition*. 3121–3128.

Lambeck K., Rouby, H., Purcell, A., Sun, Y., Sambridge, M., 2014. Sea level and global ice volumes from the Last Glacial Maximum to the Holocene. *Proc. Natl. Acad. Sci.* 111(43):15296–15303

Kallaher, A., Gamble, A., 2017. GIS and the humanities: Presenting a path to digital scholarship with the Story Map app. *Coll. Undergrad. Libr.*, *24*, 559–573, doi:10.1080/10691316.2017.1327386.

Lowe, D.G., 2004. Distinctive image features from scale-invariant keypoints. *International journal of computer vision*, 60(2), pp.91-110.

Malinverni, E.S., Pierdicca, R., Colosi, F. and Orazi, R., 2019. "Dissemination in archaeology: a GIS-based StoryMap for Chan Chan". Journal of Cultural Heritage Management and Sustainable Development, 9, 4, 500-519. https://doi.org/10.1108/JCHMSD-07-2018-0048

Moulon, P., Monasse, P., Marlet, R., 2012. Adaptive Structure from Motion with a contrario model estimation. *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics*) 7727 LNCS, 1–14.

Newman G., Zimmerman D., Crall A. Laituri M., Graham J., Stapel L., 2010. User-friendly web mapping: lessons from a citizen science website, International Journal of Geographical Information Science, 24, 12, 1851- 1869.

Tataris, A.A. 1997.The articulation of the paleogeographic area of the shale-chert-sandstone formation with ophiolites of Eastern Greece and the place of Salamina island and Trapezona Mt. in it. Ann. Geol. De pays Hellen., 1e SÉRIE, XXXVII, 1015-1032.

Wright, D.J., Verrill, A., Artz, M., and Deming, R., 2014 Story maps as an effective social medium for data synthesis, communication, and dissemination, *Eos, Trans. AGU*, 95, Fall Meet. Suppl., Abstract IN33B-3773, 2014.