# Preservation and Protection of Cultural Heritage in High Tourism Areas Using GIS Technology: A Case Study of the Medieval City of Rhodes

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Abstract: The Medieval City of Rhodes is one of the most famous destinations in Greece, as it attracts more and more tourists, especially during the summer season. Given that this particular site is included in the UNESCO list, its protection and preservation are of utmost importance. Through a literature review, an effort is made to analyse the phenomenon of overtourism in the area. Both quantitative and qualitative data available on the topic were used from various sources in order to accurately frame the issues and implications of the phenomenon. Finally, several proposals are provided using a mix of strategies and mitigation measures relevant to the issue, emphasizing the importance of using QGIS.

## 1 INTRODUCTION

The Medieval City of Rhodes, a UNESCO World Heritage Site, is a remarkable example of medieval architecture including structures for residential, military, commercial, public and religious use (UNESCO, 1988). Specifically, it is particularly known for the interesting dialogue between these different kinds of buildings, as it offers a glimpse into both antiquity and the complex history of the Crusades and subsequent periods of influence, with ancient remains, primarily temples, and its impressive Medieval and Ottoman structures. However, the city faces increasing challenges that threaten both its physical integrity and its cultural heritage (UNESCO, 1972) (UNESCO, 2016).

Due to its location and history, the Medieval City of Rhodes attracts an increasing number of visitors, which, despite the economic benefits, may lead to overtourism (Avdikos, 2011). As the city is filled with narrow streets and ancient and medieval buildings that were not designed to have large numbers of tourists, their deterioration is likely. Additionally, overcrowding impacts visitors' experience and leads to physical degradation of the landscape (ICOMOS, 2001-2002), (García-Hernández, Dela Calle-Vaquero, & Yubero, 2017).

The Medieval City of Rhodes, apart from overtourism, is facing crucial environmental threats due to climate change. Higher temperatures are causing cracks and erosion in the stone structures, while rising sea levels and storms threaten the city's fortifications. Furthermore, earthquakes in the region heighten the risk of damage. These threats require immediate action to protect the cultural heritage of Rhodes (European Union, 2019).

In order to address these challenges, the use of modern technology is necessary. Geographic Information Systems (GIS), particularly QGIS (Quantum Geographic Information System), provide powerful tools for analyzing spatial data and managing complex urban environments. Some of its advantages pertain to the capability of mapping, visualizing, monitoring and analyzing various aspects of the city's physical and environmental conditions, providing researchers with the chance to propose mitigation strategies and protection measures (National Geographic, n.d.).

The aim of this report is to examine the various challenges facing the Medieval City of Rhodes with a focus on the dual threats of overtourism and environmental risks driven by climate change. By understanding the important vulnerabilities of this historic region, the report seeks to explore how Geographic Information Systems (GIS) can be used



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to monitor, analyze and develop strategies to mitigate these risks. Ultimately, the purpose is to propose sustainable solutions to protect both the physical integrity and the cultural heritage of the Medieval City of Rhodes for future generations.

## 2 CASE STUDY

Rhodes is the largest island in the Dodecanese and is known for its long and important history dating back to ancient times. Its strategic location in the eastern Aegean Sea made it a crossroads between East and West, as well as North and South. Archaeological evidence indicates that the island of Rhodes has been inhabited since the New Stone Age, and by the 11th century BC, it was settled by the Dorians who established the city-states of Ialysos, Kamiros, and Lindos. Another important section of island history is the fact that Rhodes continued to play an important role in the ancient world, particularly through its colonies, such as Gela in Sicily (UNESCO, 1988).

The Medieval City of Rhodes, located at the northern tip of the island, became significant during the Crusades, when the Knights Hospitaller took control of the island in 1309. In particular, the island was initially developed into a fortified stronghold that used to provide medical services to Crusader knights, creating its medieval character. Specifically, the Knights were responsible for the city's architectural development, constructing fortifications, gates and other characteristic buildings that still dominate the urban landscape. Despite numerous challenges, including sieges, natural disasters and Ottoman occupation, Rhodes maintained its historical significance and integrity (UNESCO, 1988) (Luttrell, 2003).

The historical and architectural value of the Old Town of Rhodes is the reason why UNESCO included the site in its World Heritage List. For instance, its fortifications, influenced by Gothic and Ottoman architecture, are remarkable examples of medieval military construction and offer deep insight into these type of structures in the eastern Mediterranean. Therefore, it is important to preserve the original building materials of buildings and the urban organization in order to maintain the authenticity of the city. However, modern pressures, such as overtourism and environmental impacts, pose threats to the city's integrity, necessitating mitigation strategies that could aid in the protection and preservation of its historical and cultural significance (García-Hernández, De la Calle-Vaquero, & Yubero, 2017).

Figure 1: The Medieval City of Rhodes (UNESCO, 1988).

### 2.1 Threats

The island of Rhodes, like many Mediterranean regions, is characterized by a great number of threats that are connected to its geographical location and the effects of climate change that can be observed, especially in recent years. In general, the results of climate change are apparent both worldwide and specifically in Rhodes impacting the natural and cultural history of the island (European Commission, n.d.) (Gruber, 2011) (Sesana, Gagnon, Ciantelli, Cassar, & Hughes, 2020).

#### 2.1.1 Temperature

Extreme weather events, including heatwaves, are a significant threat. The decade from 2011 to 2020 was the warmest on record for the island with the data showing that Rhodes is getting warmer, with 2023 being the warmest year at 20.4°C. The increase in temperature deteriorates heritage materials exposed to sunlight and promotes invasive species like the lionfish Pterois miles, affecting local marine life and tourism (Lindsey & Dahlman, 2024) (Meteoblue, n.d.).

#### 2.1.2 Wildfires

Higher temperatures contribute to the risk of wildfires. The EU Environment Program predicts a 14% increase in wildfires by 2030 and 50% by 2100. In summer 2023, Rhodes faced severe wildfires, with around 175,000 acres burned, including protected areas and agricultural land (Jones, Burton, Kelley, & Doerr, 2023).

#### 2.1.3 Coastal Erosion

Coastal erosion is exacerbated by rising sea levels and tectonic activity. The island is in a tectonically active

region, impacting its coastline dynamics. Since 1880, global sea levels have increased by 21-24 cm, affecting Rhodes' coastal zones and historical sites, including the Medieval City (Vandarakis, et al., 2021).

### 2.1.4 Precipitation / Rainfalls

Rhodes experiences scarce and heavy rainfalls. In 2023, it had only 332 mm of rain, one of the driest years in recent history, something that can lead to wildfires. On the other hand, heavy rains can cause flooding and landslides, as seen in 2013 and 2023 (Meteoblue, n.d.).

### 2.1.5 Earthquake

Rhodes has a history of significant earthquakes. In fact, during the medieval period, some significant earthquakes occurred in Rhodes affecting island's structures. For instance, in 1957, an earthquake caused a plethora of damages in structures in the Old Town (Papadopoulos, 2014, p. 181).

## 2.2 The Negative Impact of Overtourism

Overtourism is one of the most important threats that the Old City of Rhodes faces. In fact, increased tourism is strictly connected with overcrowding. This phenomenon is mainly visible during summers that are the peak tourist seasons. In particular, the influx of visitors leads to congestion in the city's narrow streets that originally designed for limited pedestrians. However, overcrowding not only diminishes the visitors experience, but also accelerates the wear and tear on historic buildings and roads (Alamineh, Hussein, Mulu, & Taddesse, 2023) (ICOMOS, 2001-2002).

The constant foot traffic can lead to the deterioration of old stone facades and vibrations in cobblestone pavements, threatening the structural integrity of these historical structures. Moreover, overtourism can result in environmental degradation, which is another critical issue. Specifically, overcrowding leads to pollution, including air, water, and noise pollution, as, for example, the demand for natural resources, such as water, rises significantly, often exceeding the area's capacity (Esteban-Cantillo, Menendez, & Quesada, 2024).

Another important negative impact of overtourism pertains to the commercialization of the Old City, which impacts its authenticity, leading to the loss of its original purpose and meaning. Commercialization is also connected with the constant reuse of medieval buildings of the town in order to create more hotels, restaurants, shops or anything else that pertains to tourists' needs (Giannakopoulos, et al., 2022).

Last but not least, overtourism negatively affects the local residents. Overcrowding, noise pollution, and rising rental prices make it increasingly difficult for locals to maintain their quality of life, especially during the tourist season. This imbalance highlights how overtourism affects not only the integrity of the Medieval City of Rhodes but also the well-being and the everyday-life of its inhabitants (Shahzalal, 2016).

## 2.3 Mitigation Strategies

The Medieval City of Rhodes faces significant challenges from increasing tourism, environmental degradation, and natural disasters. To address these issues in an effective way, QGIS (Geographic Information System) provides a powerful tool for creating data-driven strategies to mitigate risks and protect the city's cultural and natural heritage (National Geographic, n.d.). Here are some key mitigation strategies utilizing QGIS:

1. **Real-Time Visitor Flow Monitoring**
   Through QGIS, authorities can identify the most overcrowded areas of the city by tracking the movements of tourists in real time. This provides the opportunity of control visitors flow and propose redirections to tourists in order to congested roads be avoided reducing the pressure of specific areas of the town.
2. **Predicting Impact on Vulnerable Areas**
   The identifications of vulnerable areas to wear and tear because of overcrowding is crucial and the QGIS software can help. Specifically, data analysis through this tool may aid in predictions regarding these areas and taking appropriate measures, like installing protective barriers or limiting visitor access during peak times.
3. **Scenario Planning for Visitor Management**
   This software has the ability to model various visitor flow scenarios, something that helps city planners manage the impact of tourists, including entry time regulations or proposing alternative routes.
4. **Visualizing Environmental Impacts**
   Through QGIS environmental data are also available. For instance, the identifications of alterations in coasts can be visualized, enabling authorities understand the

development of the phenomenon and take relevant mitigation measures in order to protect the integrity of the historical site.

5. **Creating Pedestrian-Only Zones**
   As the use of QGIS provides city planners with the knowledge of areas of the town with heavy tourist activity they have the ability to propose pedestrian-only zones so as to protect the cobblestone roads and improve both the visitors' experience and the everyday life of locals. Thus, in this map, an effort is made to present the proposed Vehicle Ban Section. This specific layer is depicted with a dotted black line, indicating sections where vehicle access might be restricted in the future to preserve the historical integrity of the area. This map is a valuable tool for managing tourist flows and urban planning within the Medieval City. By distinguishing historical buildings, open spaces, and proposed vehicle-free areas, it helps planners balance preservation with modern demands of overtourism and overcrowding.

In conclusion, QGIS plays a critical role in creating and implementing mitigation strategies for the Medieval City of Rhodes. By integrating data on visitor flow, environmental impacts, and heritage vulnerability, QGIS enables authorities to make informed decisions that protect the city's historical integrity while ensuring sustainable tourism practices.

## 2.4 Using QGIS for Visualization

The preservation and management of historical sites like the Medieval City of Rhodes require not only traditional methods of conservation but also modern technological tools. Geographic Information System (GIS) software, particularly QGIS, plays a crucial role in this process. QGIS is increasingly becoming an invaluable resource for urban planners, archaeologists, and conservationists alike, providing a way to monitor, document, and manage complex environments like Rhodes (Petrescu, 2007).

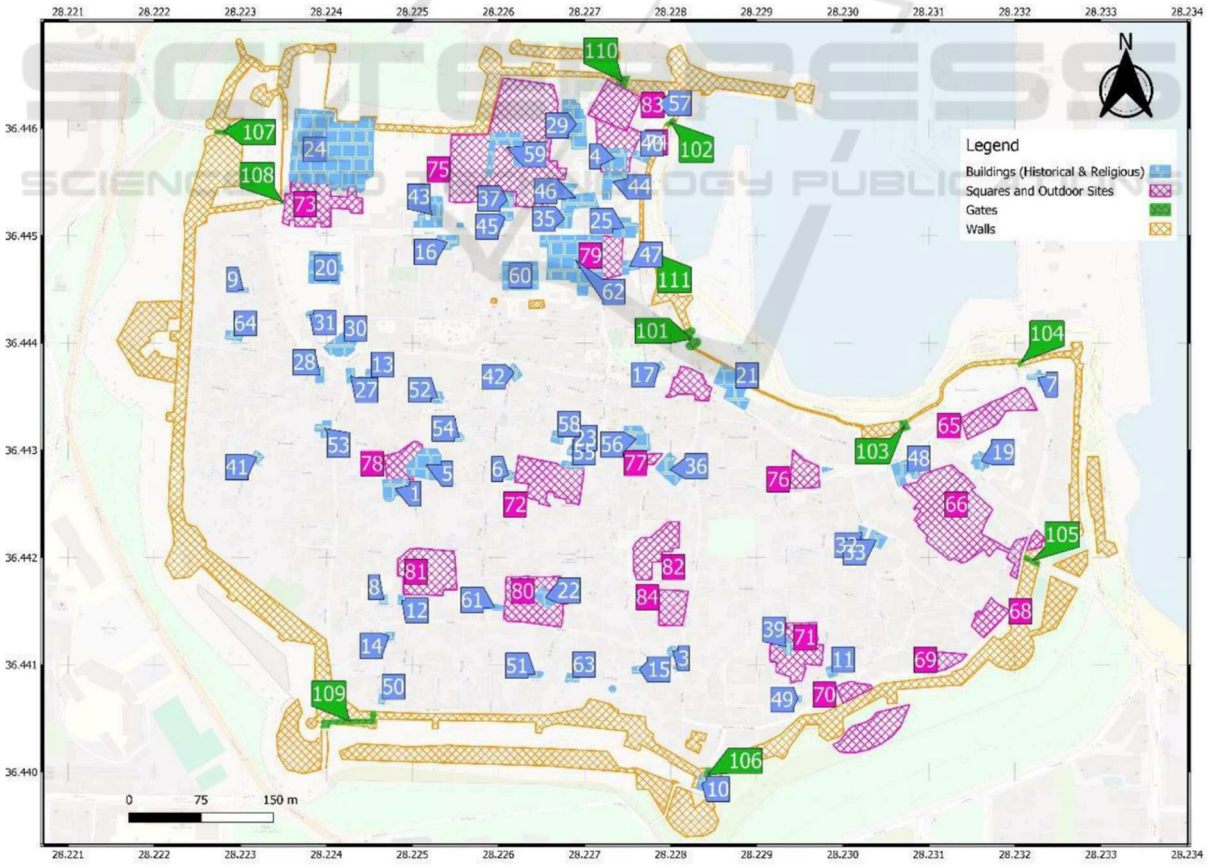


Figure 2: The Medieval City of Rhodes (created using QGIS).

The current state of the Medieval City of Rhodes is presented in detail through the use of QGIS. The use of QGIS is particularly important as it contributes both to a better understanding of the area and to its protection, whether from the significant impacts of natural disasters or from the effects of increasing tourism in the region. What it especially helps with is the improved management of the archaeological site. This is mainly achieved due to the fact that QGIS allows for the creation of accurate and detailed maps, including historical buildings, walls, roads or anything else needed. Essentially, these specific maps contribute to the continuous monitoring of the condition of the research points within the archaeological site, while making it easier to understand any changes occurring in different zones, helping to preserve the integrity of the site (Petrescu, 2007).

Of course, it is worth noting that a QGIS map is particularly helpful in monitoring the medieval city concerning natural disasters and the impacts of climate change. In fact, this island is especially exposed to several natural disasters, such as earthquakes, extreme temperatures or floods. Thus, the application of the software can assist in visualizing specific areas that are more vulnerable and ultimately create a city plan, helping researchers prioritize the issues that arise. In addition, the creation of maps with QGIS for the Old Town of Rhodes is important for the overall management of the city. For example, through the different layers, historical buildings can be easily distinguished from newer constructions, or even the most frequented by tourists, streets can be highlighted, aiming for a more effective management of overtourism on the island. In conclusion, the use of QGIS for mapping and visualization of the Medieval City of Rhodes is highly important for the optimal preservation and protection of the site, as it enables successful urban planning, monitoring, and overall management of the archaeological site.

As one of the most important steps aimed at addressing various threats and issues related to the Medieval City of Rhodes is the accurate understanding of the area and its significant structures, the mapping process through QGIS is particularly useful. Thus, in this case, the mapping of the archaeological site was mainly done to distinguish certain buildings, structures, and roads. Specifically,

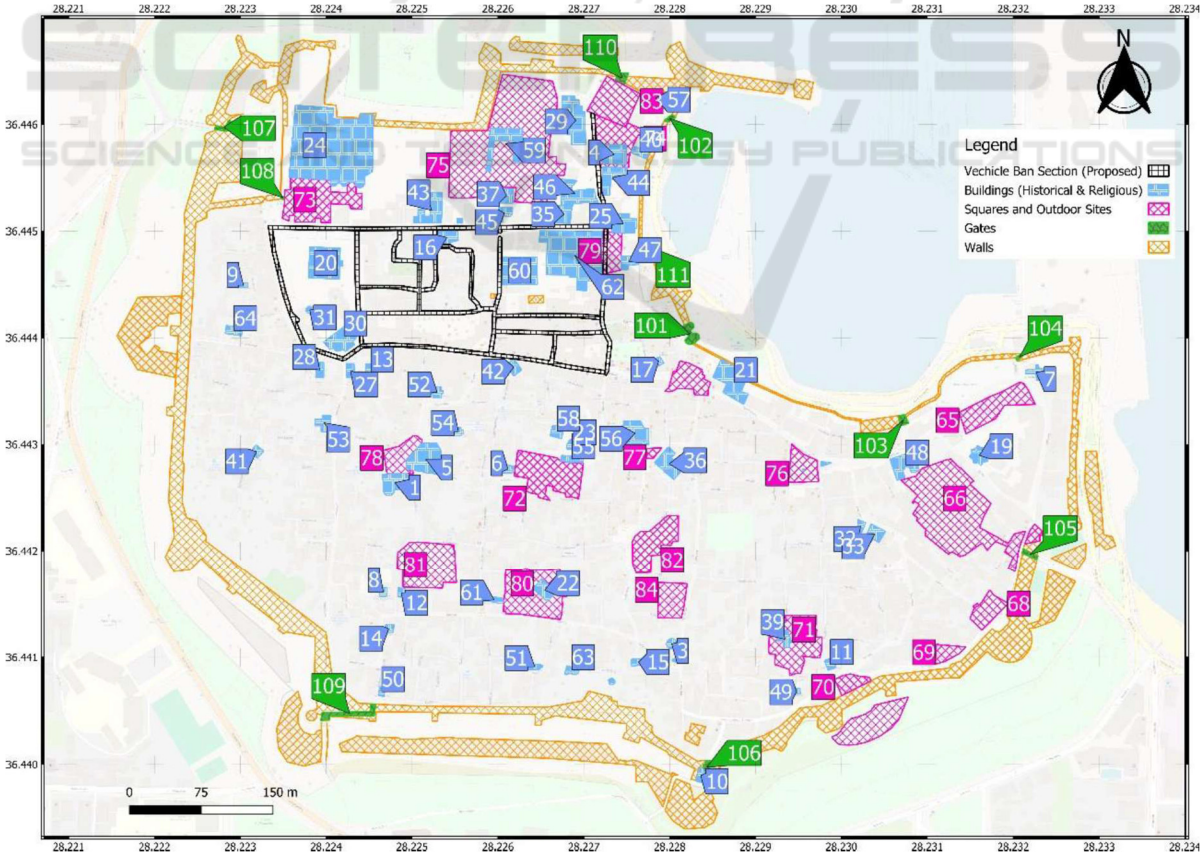


Figure 3: The Medieval City of Rhodes with proposed section of pedestrian only zone (created using QGIS).

the buildings, structures, and roads are represented on the map using different colours and shapes, forming distinct layers:

- Buildings (Historical & Religious): Represented in blue. These are significant structures within the medieval city, likely indicating historical or religious buildings. They are marked with numbers for reference and are scattered throughout the city. Their distribution offers insight into the concentration of important buildings within the medieval city.
- Squares and Outdoor Sites: Depicted in pink with cross-hatching, these areas indicate open spaces such as public squares or other significant outdoor sites. Their placement on the map highlights the spatial relationship between the built environment and open spaces, critical for understanding the urban area structure of the city.
- Gates: Shown in green, the map identifies several gates along the city walls. These gates would have been points of entry and exit from the medieval city. In fact, the gates are part of the city's historic fortifications and are vital for controlling access to the city. Their positioning is crucial for analyzing how people entered and exited the city, both historically and in modern times, particularly in relation to tourism flow. Walls: The city walls are represented by a yellow-orange cross-hatched line surrounding the city. These walls form a protective barrier around the city and are a key feature of its medieval fortifications, emphasizing its historical strategic importance.

As mentioned above, the map of the Old Town of Rhodes created through QGIS facilitates the precise identification of each building or open space, which are numbered with details such as their names and uses. It is worth noting that the visualization of these current structures contributes to highlighting the city's architecture, while also providing information on how the urban design can impact daily life and tourist activity within or outside the city.

# 3 CONCLUSIONS

In conclusion, the important phenomenon of overtourism has become a significant global concern that impacts more and more destinations worldwide. This is primarily because, along with the rise of the phenomena of climate change affecting our planet, it may lead to horrible effects, both regarding the preservation of global cultural and natural heritage and regarding people's everyday-lives (Nugroho & Hardilla, 2020). This basically includes the daily lives of local communities that are disrupted by overtourism in affected areas, as well as the experiences of tourists, who eventually do not enjoy their trips due to this serious phenomenon. Local authorities and countries, especially those that have already affected the consequences of overtourism, should take specific mitigation measures in order to protect cultural heritage and themselves. In order to achieve this, the use of modern technology and especially the use of GIS are essential.

In Greece, a country renowned for its rich cultural attractions, the Medieval City of Rhodes stands out as a prime example of how overtourism along with the effects of climate change can impact a historically significant site. The city's narrow streets and medieval architecture are particularly vulnerable to the pressures of heavy tourist traffic. Without appropriate measures, the integrity of this archaeological site is at risk.

In conclusion, the future of the Medieval City of Rhodes depends on a multi-faceted approach that combines traditional conservation methods with modern technological innovations. Geographic Information Systems, specifically QGIS, provide a crucial platform for analysing, managing, and protecting this historical site. The lessons learned from this case study can serve as a model for other historical cities worldwide that face similar challenges in balancing preservation with tourism and environmental pressures.

# REFERENCES

Alamineh, G., Hussein, J., Mulu, Y., & Taddesse, B. (2023, June 17). *The negative cultural impact of tourism and its implication on sustainable development in Amhara Regional State*. Retrieved from tandfonline.com: https://www.tandfonline.com/doi/full/10.1080/23311983.2023.2224597

Avdikos, V. (2011). *Local hegemonic blocs: The case of tourism in Rhodes*. Retrieved from academia.edu: https://www.academia.edu/561874/Local_hegemonic_blocs_The_case_of_tourism_in_ Rhodes

Esteban-Cantillo, O., Menendez, B., & Quesada, B. (2024, April 15). *Climate change and air pollution impacts on cultural heritage building materials in Europe and Mexico.* Retrieved from sciencedirect.com: https://www.sciencedirect.com/science/article/pii/S0048969724010842

European Commission. (n.d.). *Causes of climate change.* Retrieved from climate.ec.europa.eu: https://climate.ec.europa.eu/climate-change/causes-climate-change_en

European Union. (2019). *European framework for action on cultural heritage.* Retrieved from op.europa.eu: https://op.europa.eu/en/publication-detail/-/publication/5a9c3144-80f1-11e9-9f05- 01aa75ed71a1

García-Hernández, M., De la Calle-Vaquero, M., & Yubero, C. (2017, August 4). *Cultural Heritage and Urban Tourism: Historic City Centres under Pressure.* Retrieved from mdpi.com: https://www.mdpi.com/2071- 1050/9/8/1346

Giannakopoulos, D., Karekou, Z., Menegaki, E., Tsilimantou, E., Ioannidis, C., Maistrou, E., Moropoulou, A. (2022, August 1). *Reuse of Historic Buildings in the Medieval City of Rhodes to Comply with the Needs of Sustainable Urban Development.* Retrieved from mdpi.com: https://www.mdpi.com/2073- 445X/11/8/1214

Gruber, S. (2011). *The Impact of Climate Change on Cultural Heritage Sites: Environmental Law and Adaptation.* In The Impact of Climate Change on Cultural Heritage Sites: (pp. 209-219). Lexxion Verlagsgesellschaft

ICOMOS. (2001-2002). *Heritage at Risk from tourism.* Retrieved from icomos.org: https://www.icomos.org/public/risk/2001/to urism.htm

Jones, M., Burton, C., Kelley, D., & Doerr, S. H. (2023, July 28). *Greece wildfires: how climate change is involved, and what we can do about it.* Retrieved from theconversation.com: https://theconversation.com/greece-wildfires-how-climate-change-is-involved-and-what-we-can-do-about-it-210404

Lindsey, R., & Dahlman, L. (2024, January 18). *Climate Change: Global Temperature.* Retrieved from climate.gov: https://www.climate.gov/news-features/understanding-climate/climate- change-global-temperature

Luttrell, A. (2003). *The Town of Rhodes 1306-1356.* Rhodes: City of Rhodes Office for the Medieval Town (Ministry of Culture- Archaeological Receipts Fund- City of Rhodes Contract).

Meteoblue. (n.d.). *Climate Change Rhodes.* Retrieved from meteoblue.com: https://www.meteoblue.com/en/climate-change/rhodes_greece_400666

National Geographic. (n.d.). *GIS (Geographic Information System).* Retrieved from education.nationalgeographic.org: https://education.nationalgeographic.org/resource/geographic-information-system-gis/

Nugroho, A. C., & Hardilla, D. (2020, January). *The Importance of Cultural Heritage Conservation in Society: A Review and Prospect for Future Cities, with Bandar Lampung as Cased Study.* Retrieved from researchgate.net: https://www.researchgate.net/publication/338351963_The_Importance_of_Cultural_Heritage_Conservation_in_Society_A_Review_and_Prospect_for_Future_Cities_with_Bandar_Lampung_as_Cased_Study

Papadopoulos, G. (2014). *Rhodes: Earthquakes and Tsunamis from Antiquity to the Present Day.* Athens: Aselotos Publications.

Petrescu, F. (2007, October). *The Use of GIS Technology in Cultural Heritage.* Retrieved from researchgate.net: https://www.researchgate.net/publication/228636422_The_use_of_GIS_technology_in_cultural_heritage

Sesana, E., Gagnon, A. S., Ciantelli, C., Cassar, J., & Hughes, J. J. (2020, March 31). *Climate change impacts on cultural heritage: A literature review.* Retrieved from wires.onlinelibrary.wiley.com: https://wires.onlinelibrary.wiley.com/doi/epdf/10.1002/wcc.710

Shahzalal. (2016). *Positive and Negative Impacts of Tourism on Culture: A Critical Review of Examples from the Contemporary Literature.* Retrieved from https://core.ac.uk/download/pdf/234696865.pdf

UNESCO. (1972, November 16). *Convention Concerning the Protection of the World Cultural and Natural Heritage.* Retrieved 2024, from whc.unesco.org: https://whc.unesco.org/en/conventiontext/

UNESCO. (1988). *Medieval City of Rhodes.* Retrieved from https://whc.unesco.org/en/list/493/

UNESCO. (2016). *The Protection of Cultural Heritage.* Retrieved 2024, from en.unesco.org: https://en.unesco.org/creativity/policy-monitoring-platform/protection-cultural- heritage

Vandarakis, D., Panagiotopoulos, I. P., Loukaidi, V., Hatiris, G.-A., Drakopoulou, P., Kikaki, A., Kapsimalis, V. (2021, August 7). *Assessment of the Coastal Vulnerability to the Ongoing Sea Level Rise for the Exquisite Rhodes Island (SE Aegean Sea, Greece).* Retrieved from mdpi.com: https://www.mdpi.com/2073- 4441/13/16/2169