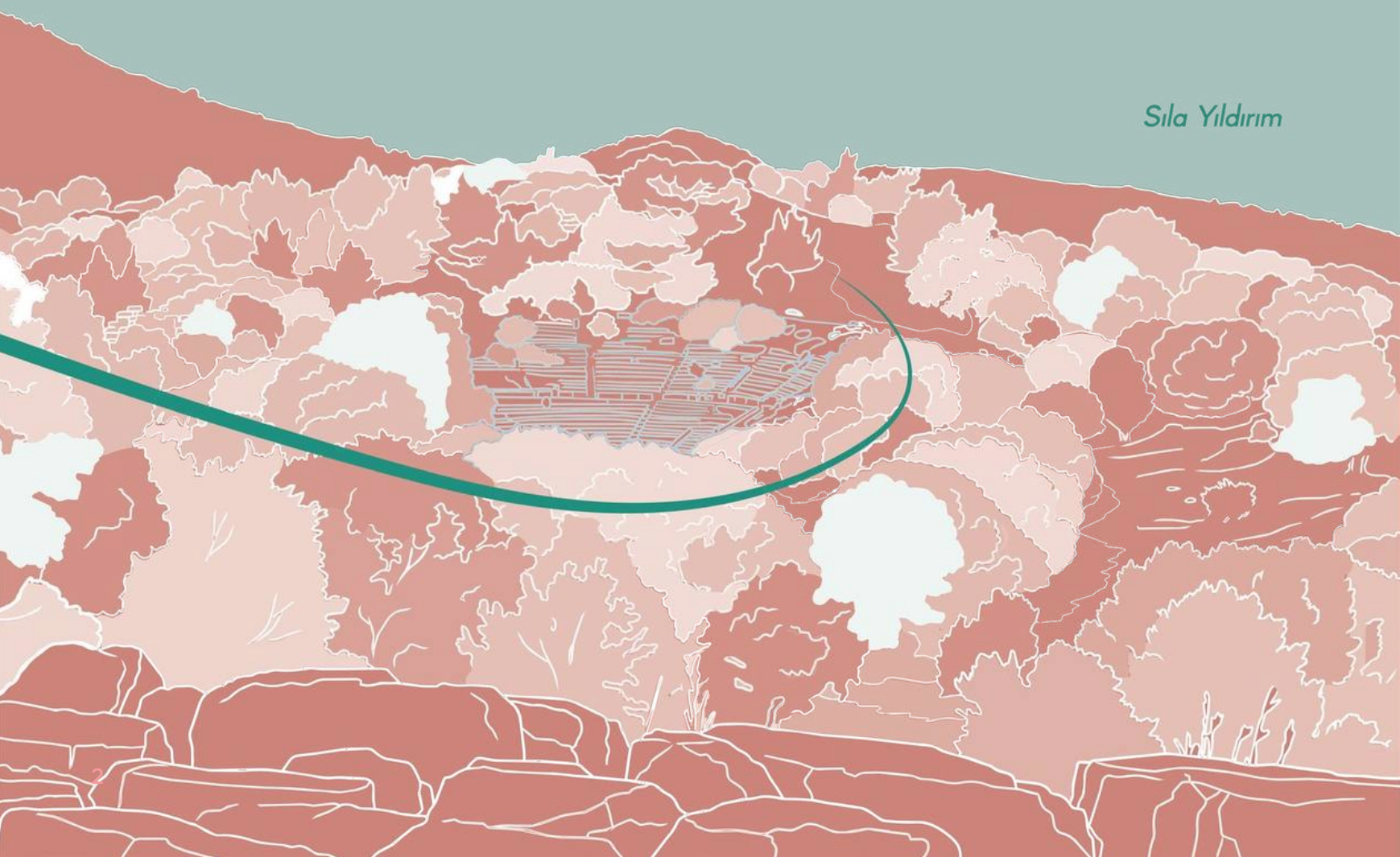
A LIVING ARCHAEOLOGICAL HERITAGE

Conservation, Memory and Reinterpretation in the Ancient City of Notion

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POLITECNICO DI TORINO

Masters in Architecture Construction City
A.Y.2025-2026 - July 2026

A Living Archaeological Heritage

Conservation, Memory and Reinterpretation in the Ancient City of Notion

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The city does not tell its past, but contains it like the lines of a hand.

Italo Calvino, Invisible Cities, 1972

I would like to begin by thanking everyone who guided me through my academic journey at Politecnico di Torino, a city that over the years became one I never quite wanted to leave.

I am deeply grateful to my supervisor, Professor Morezzi, whose patience and generosity helped me discover what genuinely excites me in architecture and pushed me to develop further than I thought I could. His classes opened a way of thinking that I had not encountered before, and it was through his teaching that I discovered this field as something that genuinely excites me; an interest I hope to keep exploring long after this thesis. This feels like only the first step of a much longer academic journey.

My dear family has been my quiet support throughout all of this, and I am grateful for every encouragement they offered from afar. I am also thankful for my friends, who stood by me through every difficult moment and made Turin a city I am not sure I will ever truly leave behind. The Ceaser family's generosity throughout my research meant more than I can properly express here.

Last but not least, my beloved Bean, whose presence beside my desk was a constant reminder that there is always a reason to smile.

ABSTRACT

The Notion Ancient City represents more than a conventional archaeological site. Its abandonment over two thousand years has gradually evolved it into a living archaeological landscape, characterised by the relationship between its ruins and vegetation. However, this thesis adopts an approach that treats the patina del tempo not as decay to be removed but as a constitutive part of the ruin's identity and value. It argues that this ruin-nature symbiosis can be maintained within a framework of managed coexistence for the archaeological landscape, rather than viewing nature only as a threat to be cleared from the ruins. Within this framework, the theater of Notion has been investigated as the primary case study, as it represents the most intense relationship with vegetation and the highest vulnerability within the ancient city.

The research follows a multidisciplinary diagnostic approach that combines an intrinsic/extrinsic vulnerability assessment (Risk = Hazard × Vulnerability), a species-by-species vegetation analysis utilising Signorini's Hazard Index (IP) and biomechanical evaluation, and a survey of stone pathologies following the Italian standard for alteration patterns.

Significantly, these diagnostic evaluations of vegetation and pathologies are not applied to justify total eradication. Instead, they serve to establish the delicate balance between vulnerability and the ruin's authentic landscape value, presenting this relationship between nature and historical character as part of the visitor experience. The intervention proposals introduced at theater scale therefore treating to plants as active instruments of preventive conservation, applied on a case-by-case basis, rather than eradicating vegetation from its living ecological context.

The design proposals aim to perceive the ancient city as more than only its abandoned ruin state, recognizing it as an archaeological landscape where visitors directly experience its identity within the ruin-nature symbiosis. The project introduces a visitor and hiking routing trail, an Information Pavilion, and an elevated Theater Passarella. The architectural proposals follow the low-impact approaches only at required points, carefully keeping the existing natural balance without disrupting the historical patina. As a result, this design framework shifts the aim of the intervention approach from complete sterilization toward maintaining a continuous dialogue between history and nature, positioning this symbiotic relationship as the core experiential character of Notion.

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01.

INTRODUCTION

1.1 Context and Theoretical Framework

In the archaeological site of Notion, the natural environment and architecture meet in an integrated rare landscape. The ruins are not static stone artifacts disconnected from their environment; rather, they represent living landscapes in continuous dialogue with their vegetative surroundings. Over two thousand years of abandonment, the entire fabric of Notion, ranging from the finest root penetrating the dry-stone Hellenistic structures to the largest conglomerate blocks, has become an organic component of a unified ecosystem where nature and history function as one living organism.

Within this context, the study engaged the flora and biological life as intrinsic components of the site's archaeological identity. Regarding the ruin aesthetic, the vegetation cover is not perceived as just pathology, but as an authentic patina of time (*patina del tempo*) that documents spatial memory, its aesthetic value, and marks the passage of centuries. By assessing the natural environment and the ruin as in harmony, the physical interactions of them have been assessed by the multidisciplinary diagnostic methods. This approach provides a for maintaining the delicate balance between the living landscape and ruin value.

The integration of the site within this vibrant ecosystem elevates the architectural design beyond conventional monumental preservation. Rather than interrupting its ruin-nature bond, this thesis aims to create a respectful dialogue between visitors and the archaeological landscape. Through the strategic placement of guiding architectural elements, the design proposals aim to safely organize the visitor access to the site and to the ruins to transform the abandoned city into an accessible and publicly interpreted archaeological park.

1.2 Problem Statement

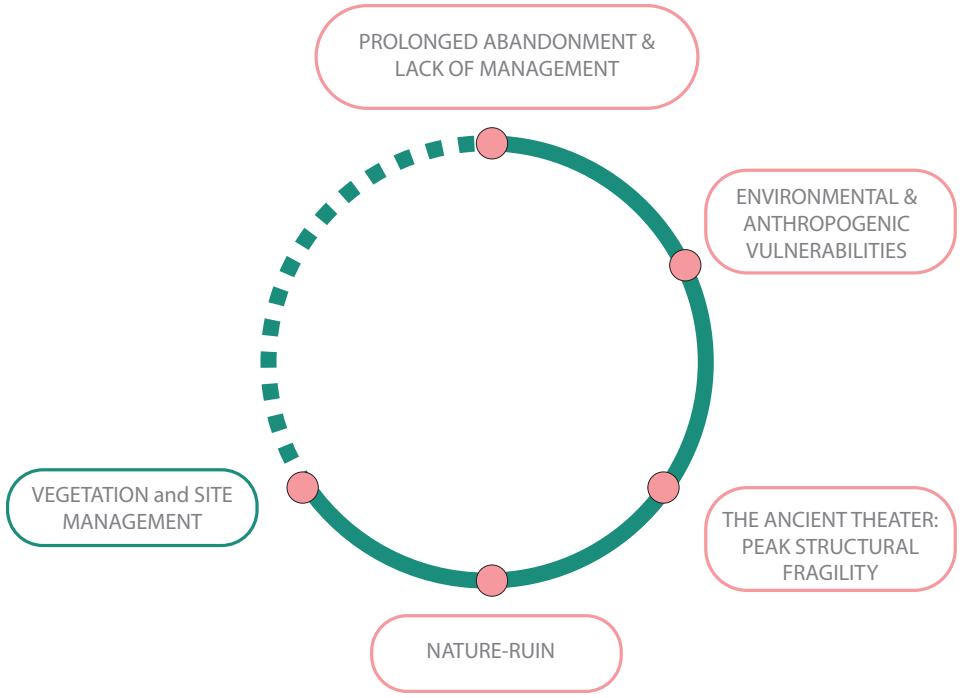


Figure 1. Diagram of the problem statement and the conceptual framework of the study. Diagram by the author.

The *managed coexistence* approach at the site of Notion has evolved into a critical conservation requirement. Since its abandonment during the Byzantine period, the site has lacked essential visitor infrastructures, access control, and comprehensive monitoring. Notably, the theater addresses these vulnerabilities, thereby standing as the primary case study of this conflict where architectural vulnerability meets vegetation dominance.

The theater's cavea, consisting of the porous, mortarless conglomerate stone, exhibits high bioreceptivity, providing an ideal substrate for the biological colonization and biodeterioration. Notably, attempts at the total eradication of flora pose a secondary threat; because the root system induces mechanical stress on the structure and some structural stability ont he cavea, while also serving as a vital, consolidating tissue in the theater's most unstable inclined topography. Therefore, the decisions must be based on case-by-case evaluations in order to develop specific solutions. Furthermore, the absence of the site management leaves the ruins exposed to continuous anthropogenic degradation, including vandalism and physical damage. Overall, the challenge of this research is to define intervention strategies that simultaneously address these issues without sacrificing the site's unique nature-ruin symbiosis (Fig. 1).

1.3 Research Question and Objectives

This study seeks to understand how quantitative vulnerability assessment tools can inform a site management strategy that preserves the ruin-nature symbiosis without compromising the historical patina of Notion. The study investigates the relationship between ruins and vegetation, and explores the effective management by seeking the methodology that simultaneously maintains the authentic identity of the site as an archaeological landscape. Moreover, the quantitative methodologies have been utilized in order to evaluate the hazards and risks generated by flora on the theater and its porous conglomerate stones.

Based on these research areas, the primary objective is formulating a multidisciplinary framework that interprets the ruin-nature cohabitation as a dynamic asset. The study establishes a diagnostic protocol using quantitative tools such as the Hazard Index (IP) and biomechanical assessments, applied through case-by-case management. The site management is implemented through access control and defined routing strategies and architectural proposals, to reduce the anthropogenic impact on the site.

The research proposes a new site management strategy by preserving the unique ruin-nature relationship as the defining character of Notion. This plan consists of access control and architectural interventions that guide visitors to experience the relationship between nature and ruins in a safe way. Essentially, this framework transforms the abandoned site into an accessible archaeological park, welcoming visitors to discover the history and the nature of Notion.

1.4 Methodology

The methodology of this thesis was organised around three sequential phases; theoretical framework, analysis and diagnosis, and improving the intervention strategies with design proposals. Each phase is structured directly upon the cumulative findings of the previous one. This structure ensures methodological consistency and logically guides the progression of the forthcoming phases.

The first step establishes the theoretical framework of the research. A systematic review of the literature was conducted alongside field observations, 3D photogrammetry and visitor experience data were collected. Photogrammetric point clouds were used to generate the base map of the theater and to identify structural deformations in the cavea seating. This comprehensive data gathering provides a base for evaluating the site's current state, its active use, and its inherent vulnerabilities.

Transitioning from the literature reviews to the analysis phase, the theoretical inputs have been analysed and utilized for detailed diagnostic evaluations. Specific quantitative and qualitative methods such as the Signorini Hazard Index, VTA and SIA were utilized to understand the archaeological site's specific sections. Specifically, the ancient theater has been selected as the primary case study. However, the diagnosis has been conducted on the theater scale in terms of vegetation hazard assessment and a systematic survey of structural pathologies in accordance with the Italian standard for the description of stone alteration forms. The utilization of the Italian standard was a deliberate preference for the methodological consistency with the Italian conservation philosophy applied throughout this research.

The final phase introduces the intervention proposals guided by the diagnostic findings. The intervention proposals include the decision process regarding vegetation management, site management, and the design of architectural elements based on the principle of minimum intervention. These proposals prioritize maintaining the landscape characteristics of the ancient city, embracing the *managed coexistence* approach, while enhancing the visitor experience and safeguarding the memory of the archaeological site and its landscape (Fig. 2).

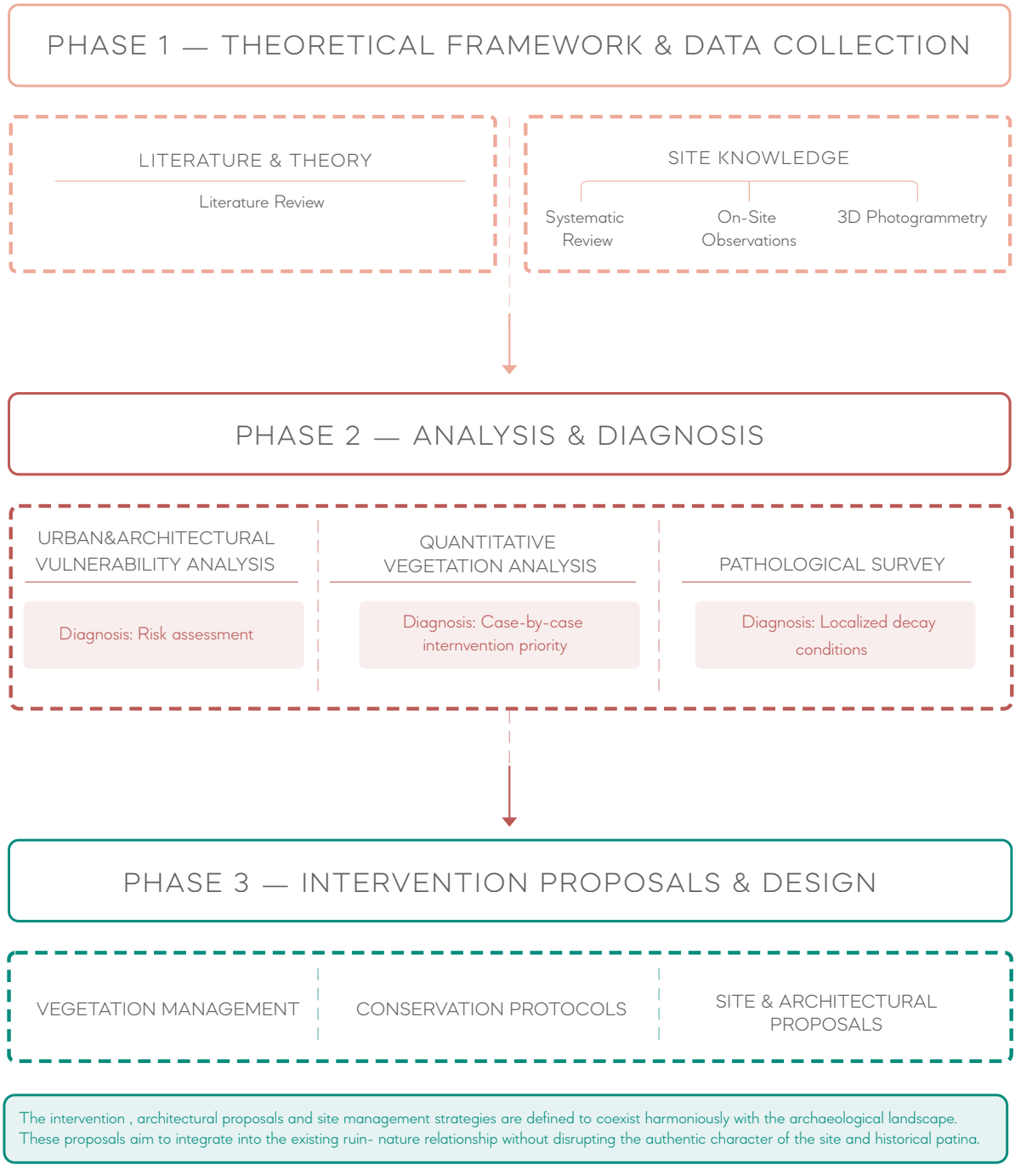


Figure 2. Methodology diagram showing the three sequential research phases. Diagram by the author.

02.

NOTION ANCIENT CITY AND HISTORICAL CONTEXT

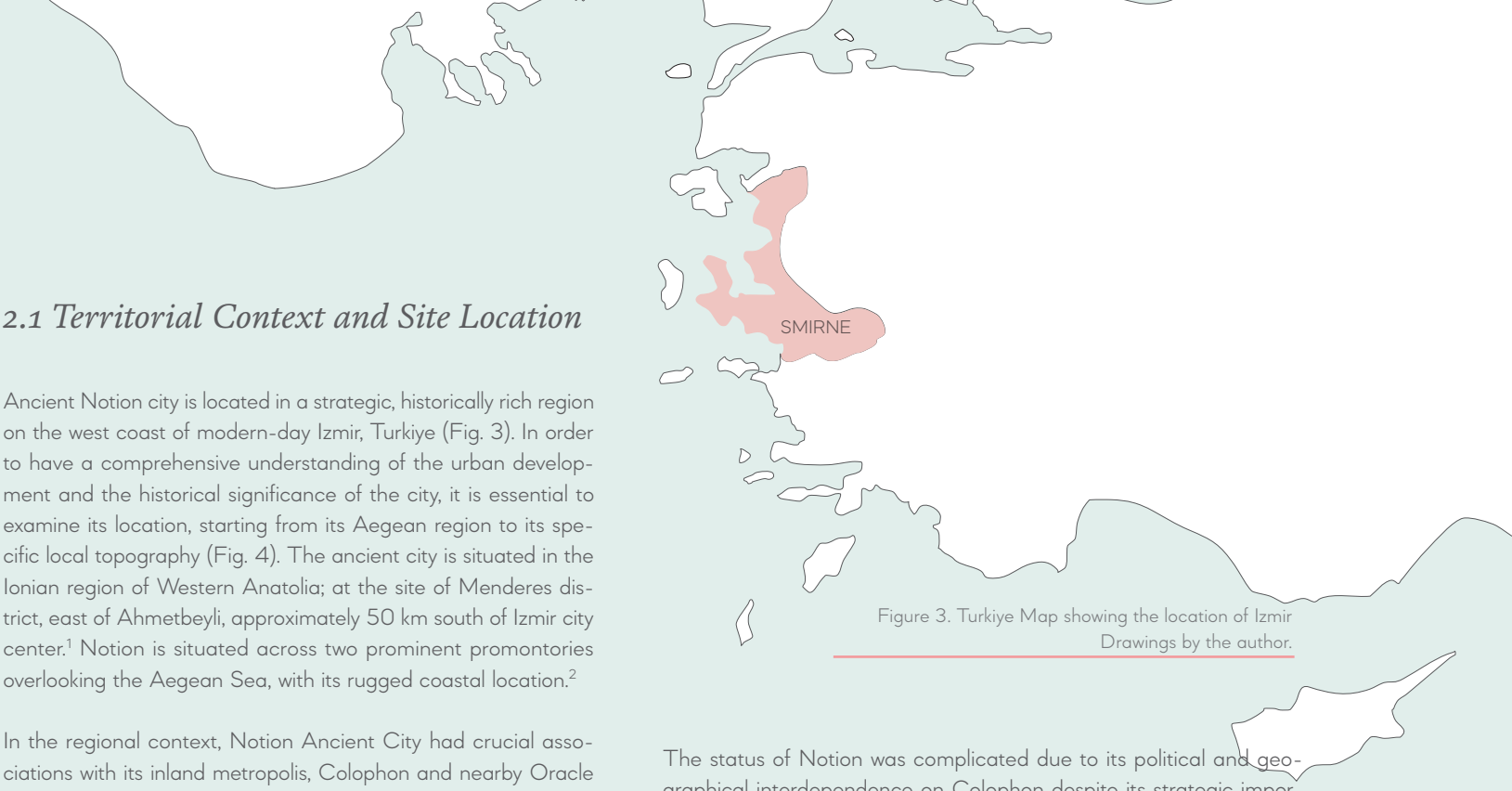


Figure 3. Turkiye Map showing the location of Izmir
Drawings by the author.

2.1 Territorial Context and Site Location

Ancient Notion city is located in a strategic, historically rich region on the west coast of modern-day Izmir, Turkiye (Fig. 3). In order to have a comprehensive understanding of the urban development and the historical significance of the city, it is essential to examine its location, starting from its Aegean region to its specific local topography (Fig. 4). The ancient city is situated in the Ionian region of Western Anatolia; at the site of Menderes district, east of Ahmetbeyli, approximately 50 km south of Izmir city center.[1] Notion is situated across two prominent promontories overlooking the Aegean Sea, with its rugged coastal location.[2]

In the regional context, Notion Ancient City had crucial associations with its inland metropolis, Colophon and nearby Oracle Sanctuary of Apollo at Klaros, located only 2 km away (Fig. 5). The name *Notion*, in Ancient Greek *Nótiov*, which literally refers to the *southern place* or *southern town*, indicates its dependent relationship with Colophon. This nomenclature points out that the primary role of Notion was the harbor city of Colophon, as situated in the geographically southern part of Colophon, main inland city. Thucydides referred the settlement of Notion explicitly as a city of Colophonians (πόλις Κολοφωνίων), however confirms its crucial role of a geographically southern harbour city of Colophon.[3]

During Hellenistic period, the political union (*sympoliteia*) between Clophon and Notion had altered significantly, Notion's name was changed in some decrees to *Kolophon by the Sea (Kolophon-epi-thalassē)*, an epigraphic confirmation of its extended role in terms of administrative and economic focal point of the territory.

The status of Notion was complicated due to its political and geographical interdependence on Colophon despite its strategic importance related to militarian and economical aspects among Ionian cities. Alongside its geographical importance, Notion Ancient City was a mandatory passage for the pilgrims visiting Oracle of Apollo at Klaros.[4] However, the remarkable inscriptions from Klaros provide important historical insights regarding the local decrees of Notion and Colophon, referring to their dependence on the sanctuary's regional prestige.[5] Today, the ancient city's remarkable remains, which have merged with nature, its rich history, and its ancient remains, have become a current field of archaeological study and are attracting more attention.[6] Correspondingly, the site has recently emerged as a focal point for archaeological investigation, owing to its key structures and remarkable urban layout. At present, the site interacts with its modern surroundings; positioned directly beside the contemporary coastal settlement and beach of Ahmetbeyli, and Boradan Bay (Fig. 6).

1. Christopher Ratté, "Archaeological Research at Notion, 2022-23," 44. Kazı Sonuçları Toplantısı Bildirileri, Vol. 4 (Ankara: Kültür Varlıkları ve Müzeler Genel Müdürlüğü, 2024), 341.
2. Christopher Ratté, Felipe Rojas, and Angela Commito, "Notion Archaeological Survey, 2014-2015," 34. Araştırma Sonuçları Toplantısı, Vol. 2 (Ankara: Kültür Varlıkları ve Müzeler Genel Müdürlüğü, 2017), 617.
3. On Thucydides' description of Notion as "a city of the Colophonians" (Thuc. 3.34) and its role as the harbour of Kolophon, see Leicester B. Holland, "Colophon," Hesperia 13, no. 2 (1944): 91–171; and Christopher Ratté, Felipe Rojas, and Angela Commito, "Notion Archaeological Survey, 2014–2015," 34. Araştırma Sonuçları Toplantısı (Edirne, 2017): 387–402.
4. Ian Rutherford,"Claros: Paideiā as a Rite of Passage," in Pilgrimage in Graeco-Roman and Early Christian Antiquity: Seeing the Gods, ed. Jas Elsner and Ian Rutherford
5. Christopher Ratté, "The Agoras of Notion in Ionia, Turkey, " in The Agoras of Notion in Ionia Turkey, (2022), 341–342. See also Ratté, Rojas, and Commito, "Notion Archaeological Survey, 2014–2015," 618. (Oxford: Oxford University Press, 2005), 135–138.
6. Christopher Ratté, Felipe Rojas, and Angela Commito, "Notion Archaeological Survey 2017–2018," Araştırma Sonuçları Toplantısı 37 (Ankara: Kültür Varlıkları ve Müzeler Genel Müdürlüğü, 2019).



Figure 4. Regional map showing Notion in relation to Izmir and the surrounding Ionian territory. Map by the author.



Figure 5. Regional map showing the relationship between Notion, its metropolis Kolophon, and the sanctuary of Apollo at Klaros. Created by the author based on Ratté and Rojas (2016).

Moreover, the archaeological site physically has a border to Seferihis-ar-Selcuk coastal highway on its north-east direction. Yet, despite its proximity to modern infrastructure and contemporary urban settlements, the site provides a distinct atmosphere. It functions as a vast, open-air archaeological landscape as a ruin, where the historical remains and the natural ecosystem exist with an interaction.

Notion Ancient City is currently an open-access site with no entry fees or modern facilities, unlike more commercialised, museum-like ancient cities. Correspondingly, the remains of the ancient city are deeply intertwined with the local flora and the vegetation. This untouched environment offers visitors a chance to literally step through a history reclaimed by nature, with its rugged terrain.

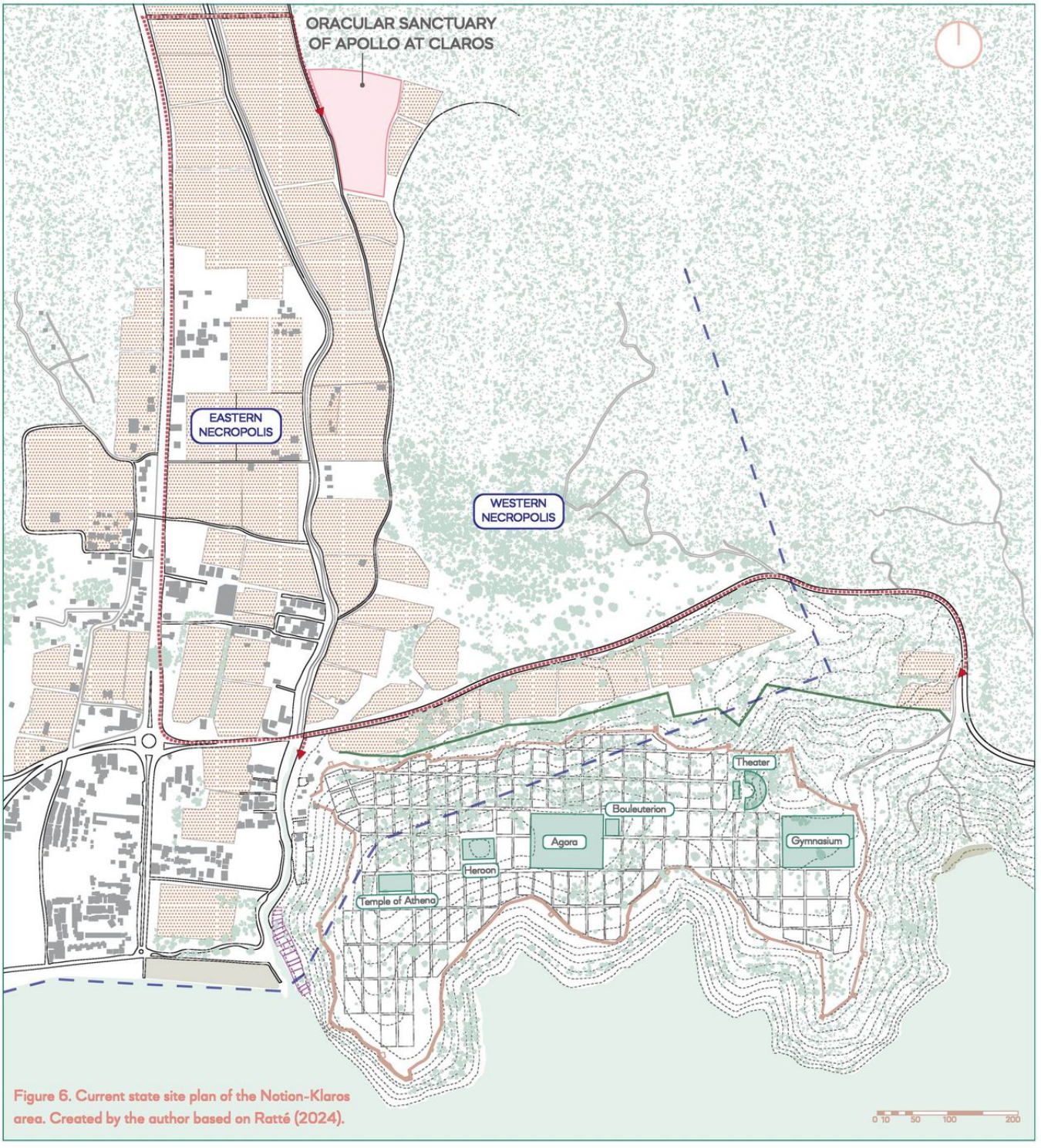
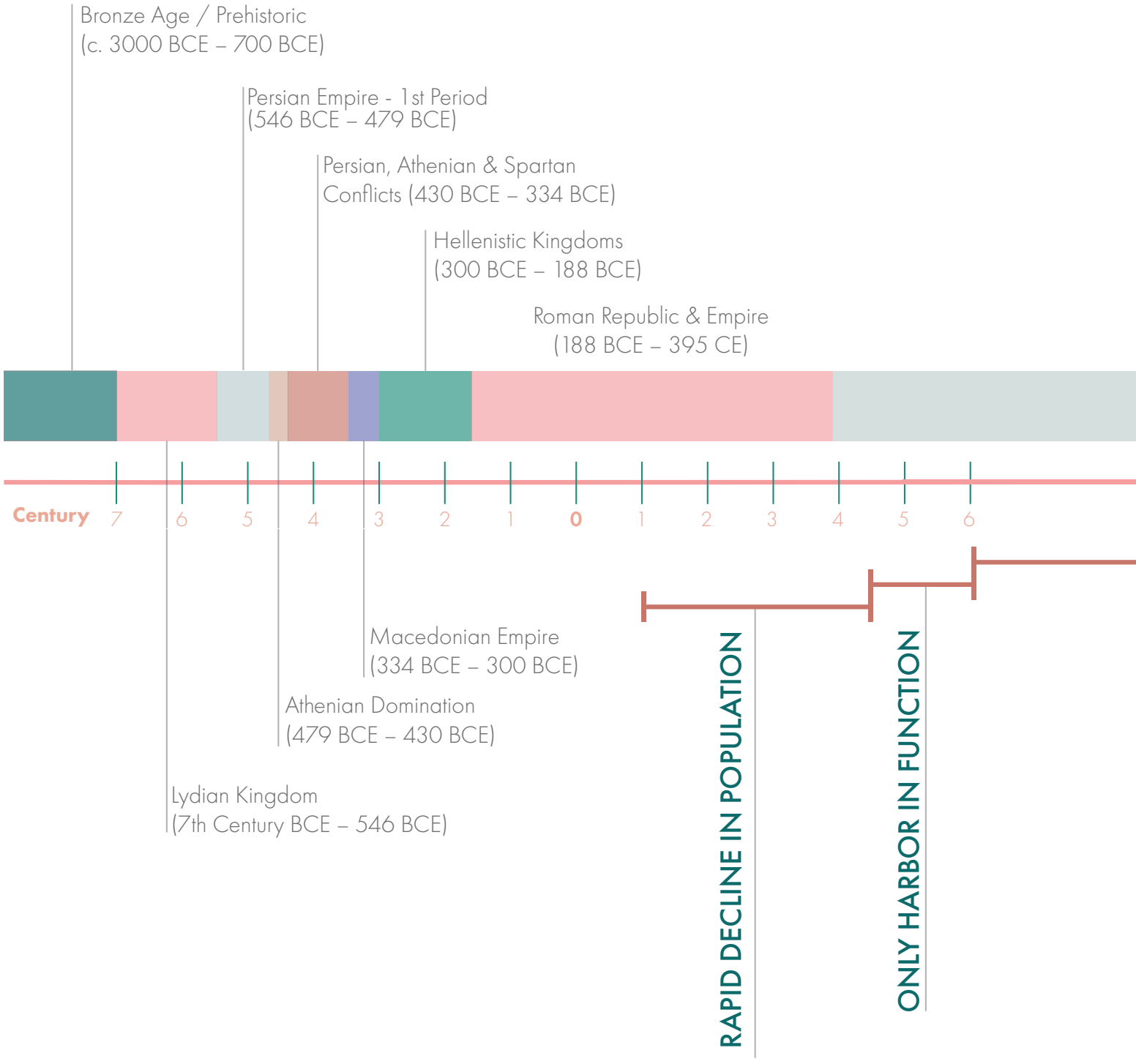


Figure 6. Current state site plan of the Notion-Klaros area. Created by the author based on Ratté (2024).

2.2 *Historical and Archaeological Background*



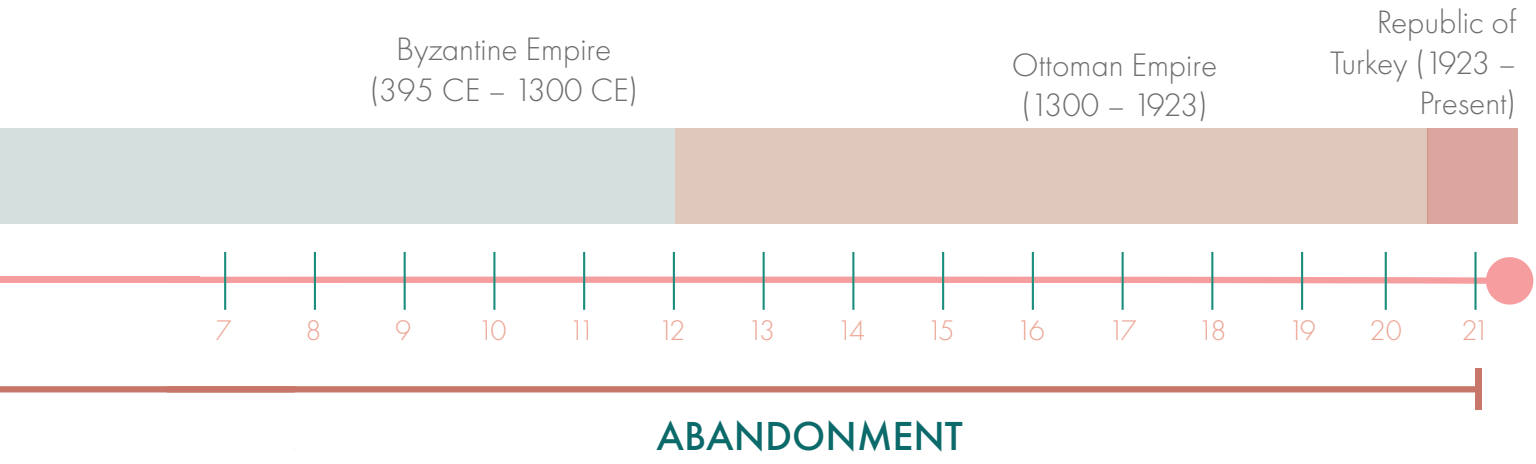


Figure 7. Historical Timeline of Notion Ancient City. Diagram by author.

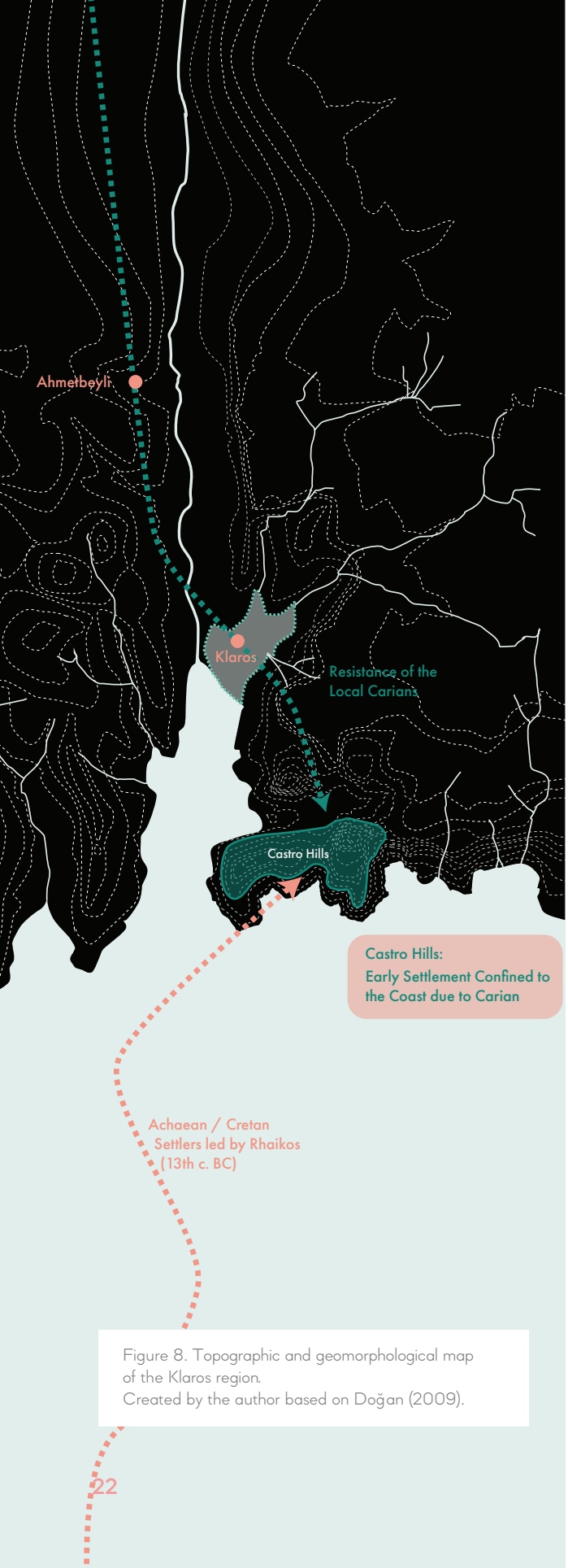


Figure 8. Topographic and geomorphological map of the Klaros region.
Created by the author based on Doğan (2009).

2.2.1 Bronze Age Settlement to 7th Century BCE

Ancient texts state that Notion was established as a Mycenaean coastal settlement in the 13th century BCE by Achaean settlers under the leadership of Rhaikos (Fig. 8). According to that, the settlers were forced to remain on the coast due to the resistance of the local Carians.[7] However, current archaeological research has not recovered any Bronze Age stratigraphic evidence at the currently visible site of Notion. [8]

In order to explain this discrepancy between the mythological origins and the visible remains, the scholars hypothesized that the Bronze Age settlements of Notion might not have situated on the current promontories. Rather, it is suggested that this early settlement may lie buried under a thick layer of alluvium brought by the Hales River, or in deeper, unexcavated layers closer to the ancient harbour.

7. Nuran Şahin, "Notion-Klaros-Kolophon Üçgeninde Myken Sorunu," in Patronvs: Coşkun Özgünel'e 65. Yaş Armağanı / Festschrift für Coşkun Özgünel zum 65. Geburtstag, ed. E. Öztepe and M.
8. Ratté, "Archaeological Research at Notion, 2022-23," 347.

2.2.2 The Archaic and Classical Periods (6th – 4th Century BCE)

The history of Notion during the Archaic and Classical periods had been shaped by its position between major Aegean and Anatolian powers. Following the regional turbulence of Ionia in the 6th century BCE, the establishment of Lydian rule and the subsequent Persian conquest of Ionia, Notion found itself deeply involved in the geopolitical struggles of the Mediterranean during the Classical period.[9]

Although Notion was geographically distinct from Colophon, it maintained a close political relationship with the inland city. The formal urban union (*sympoliteia*) between Notion and Colophon was established later in the early Hellenistic period, while their political interconnection was already deeply rooted during the Classical era.[10] However, this relationship was also about their shared association with the Sanctuary of Apollo at Claros. The Sanctuary attracted countless pilgrims passing through Notion from the surrounding regions, making the two cities a remarkable subject of interest for ancient authors. Aristotle cited Colophon and Notion as prime examples of a single political entity separated geographically, referring that such a spatial division makes a community highly susceptible to internal conflict, called *stasis* (στάσις).[11] Notably, Aristotle's observation was undoubtedly based on Notion's historical trajectory during the Peloponnesian War, when the geographical and political divide led to a severe civil war between pro-Athenian and pro-Persian factions within the city. However, the status of Notion as a minor city compared to Colophon is evident in tax records of the Delian League. [12]In the 5th century BCE, while Colophon paid a significant amount of annual tribute of three talents to the Athenian-led league, Notion contributed only one-third of a talent. [13] This difference demonstrates that Notion was economically much weaker than Colophon.

The *stasis* (civil war or civil unrest) was exposed when Colophon fell once again to the Persians in 430 BCE. Consequently, the numerous inhabitants of Colophon fled to Notion due to the civil war. The influx to Notion concluded with political fragmentation in the port city Notion. The historian records that the period of the citizens of Notion was divided; one actively supporting the Persian Empire, while the other aligned with the Athenian Confederacy. However, the urban fabric of the city was affected physically by this conflict; politically polarised citizens were separated by a physical wall, recalled as the διατείχισμα (Diateichisma).[14] This phenomenon illustrates more than a political conflict; it also demonstrates how political identity could directly have an influence on the urban layout. Thus, Notion had become one of the rare poleis compelled to defend itself from its own citizens rather than just external enemies. Following the exile of pro-Persians by the Athenian military intervention in 427 BCE, the political trajectory of Notion completely changed. The city started to serve as a crucial Athenian Military Port, a development that marked its political and administrative separation from Colophon; furthermore, it also signified a shift under the direct controlof a major Aegean power, namely Athens.

Notion's strategic importance played a crucial role during the final stages of the Peloponnesian War. The Battle of Notium (also known as the Battle of Ephesus), which took place towards the end of the Peloponnesian War in 406 BCE between Athenians and Spartans occurred just off the coast of Notion and Ephesus, concluding with a Spartan naval victory. Beyond that, before the Battle of Notium, the Athenians had achieved a series of naval victories, most remarkably at Cyzicus (410 BCE), which revitalised their confidence in their military capabilities. The Spartan victory over the Athenians in the Battle of Notium was the first major naval victory achieved by the Spartan commander Lysander against the Athenian fleet. The battle proved that the Spartan fleet-could defeat the Athenians at sea; nonetheless, ship losses were relatively high. The result of the battle was determined by the strategic tactics of the Spartan navarch, Lysander, and Antiochus's disobedience to Alcibiades's orders.

In the final stages of the Peloponnesian War, superiority on the Aegean Sea had become crucial. In 407 BCE, Lysander was appointed as the commander (navarch) of the Spartan fleet. He followed an eastward

9. For the Lydian and subsequent Persian conquests of Ionian cities, including Colophon and Notion, see Leicester B. Holland, "Colophon," Hesperia 13, no. 2 (1944): 143; see also Nuran Şahin, "Notion-Klaros-Kolophon Üçgeninde Myken Sorunu," in Patronvs: Coşkun Özgünel'e 65. Yaş Armağanı, ed. E. Öztepe and M. Kadıoğlu (Istanbul: Homer Kitabevi, 2007), 332-338.
10. Roland Étienne and Léopold Migeotte, "Colophon et les abus des fermiers des taxes," Bulletin de Correspondance Hellénique 122 (1998): 143-157.
11. Aristotle, Politics, 5.2.8 (1303a), trans. H. Rackham, Loeb Classical Library 264 (Cambridge, MA: Harvard University Press, 1932).
12. Wade-Gery, and M. F. McGregor, The Athenian Tribute Lists, 4 vols. (Cambridge, MA: Harvard University Press, 1939–1953), vol. 1. For a modern re-evaluation: see also Meiggs, The Athenian Empire (Oxford: Clarendon Press, 1972).
13. Meritt, Wade-Gery, and McGregor, The Athenian Tribute Lists, vol. 1
14. Carl Schuchhardt, "Kolophon, Notion und Klaros," Athenische Mitteilungen 11 (1886): 420



Figure 9. Map of the settlement in the Archaic-Classical period.
Created by the author based on Doğan (2009).

route from Mora to Aegean with 70 triremes and reached Ephesus. In Ephesus, he increased the number of triremes, a move that remarkably diminished the naval power of the Athenian fleet.[15]

In response to this threat, the Athenian navarch Alcibiades brought his fleet to Notium, intending to observe the Spartan fleet at Ephesus and force its commander, Lysander, into battle. This attempt to draw Lysander into battle was unsuccessful. During this period, Alcibiades left his fleet to assist Thrasybulus with the siege of Phocaea, delegating his command not to an experienced general or even a trierarch, but to his personal helmsman (kybernetes), Antiochus. This decision has been harshly criticized by both ancient historians and modern scholars.[16]

The delegated commander Antiochus disobeyed Alcibiades's order not to attack Lysander's ships. Antiochus's disobedience to this order completely altered the course of the war to the disadvantage of the Athenians. He attempted to implement a strategy that he believed would guarantee victory; however, the strategy Athens had applied in their victory at Cyzicus was not suitable for Notium, and the result was a failure.

The commander Antiochus embarked towards the Ephesian harbor with a small decoy force consisting of 10 triremes (Fig. 9). He aimed to entice the Spartan fleet to follow him, thereby allowing the main Athenian fleet waiting at Notium to trap them. However, Lysander became aware of this attempted deception and launched a well-prepared counter-attack. In this engagement, the trireme under Antiochus's command was sunk, and the Athenian commander Antiochus was killed.

As the remaining nine Athenian ships attempted to flee towards their main base at Notium, Lysander pursued them with his entire fleet (approximately ninety triremes) and caught the main Athenian fleet entirely off guard. Consequently, the Athenian fleet at Notium mounted its defense piecemeal rather than forming a coherent battle line. The well-organized Spartan fleet easily defeated the disorganized Athenians. [17]

While the Battle of Notium was a minor victory in military terms; however, it was a significant Spartan victory in terms of its political consequences.[18] By the end of the battle, the Athenian fleet had lost 22 triremes; 15 of these were captured, while 7 were sunk. In contrast, the Spartans suffered almost no losses.[19]

15. For modern historical and strategic analyses of the ancient accounts (primarily those of Xenophon and Diodorus Siculus) regarding Lysander's appointment as navarch, his assembly of the Spartan fleet at Ephesus, and the subsequent shift in Aegean naval superiority, see M. Amit, "La campagne d·Ionie de 407/6 et la bataille de Notion," Grazer Beiträge 3 (1975): 1-13; and H. R. Breitenbach, "Die Seeschlacht bei Notion, 407/06," Historia 20 (1971): 152-171.
16. For modern historical analyses of the ancient accounts regarding Alcibiades' controversial delegation of command to his helmsman and the subsequent strategic failure at Notium, see M.18 Amit, "La campagne d·Ionie de 407/6 et la bataille de Notion," Grazer Beiträge 3 (1975): 1-13.
17. For a detailed modern reconstruction of the naval tactics, the failed decoy strategy at Ephesus, and the exact ship losses during the Battle of Notium based on the classical accounts, see H. R. Breitenbach, "Die Seeschlacht bei Notion, 407/06," Historia 20 (1971): 152-171.
18. For the modern historical evaluations of the political and strategic consequences of the Battle of Notium as recorded in ancient accounts, see G. Bonamente, "La battaglia di Notion," Studi classici 9 (1971-1972): 199-218.

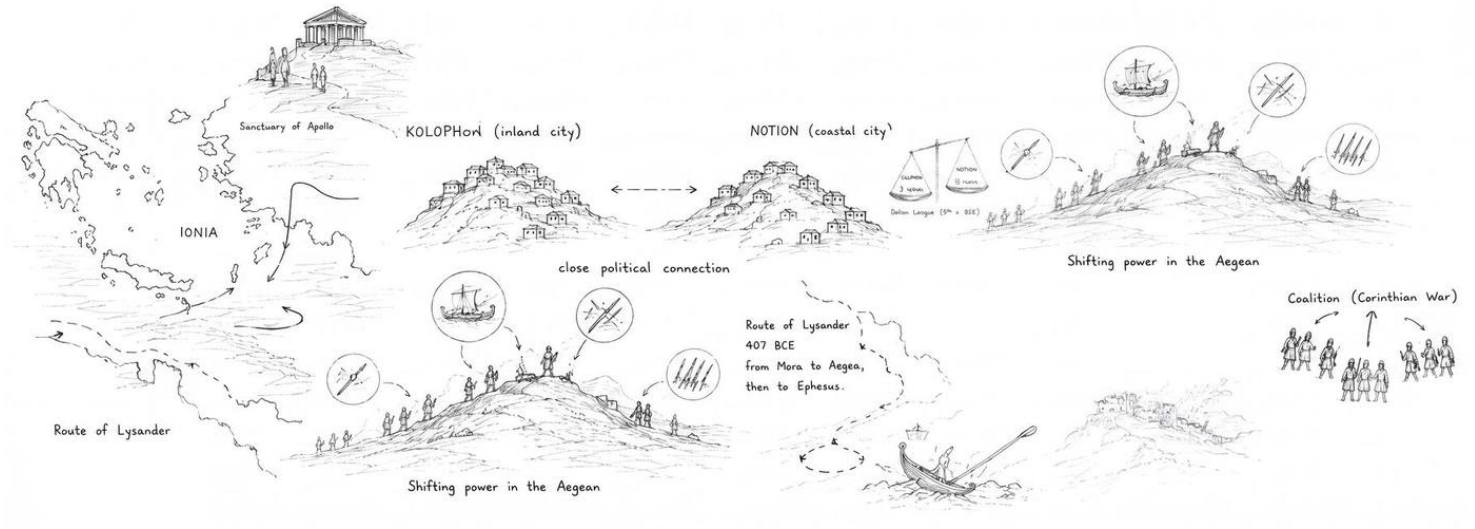


Figure 10. Sketch-Collage of political dynamics in the Classical Periods. Drawing by the author.

The Athenian commander-in-chief, Alcibiades, returned from Phocaea to his naval base at Notium upon news of the defeat and prepared for a second engagement by increasing his fleet size. However, Spartan commander Lysander refused to be drawn from Ephesus into a second battle. When news of this defeat reached Athens, Alcibiades faced accusations from his political enemies, with whom he had conflicts (notably Cleophon). These accusations included deserting his post, indirectly allowing his orders to be violated, and delegating his command to the inexperienced and unqualified helmsman, Antiochus. While Alcibiades's command (strategos) was stripped from him by the Athenian Assembly, he was exiled with his personal assets to Chersonese in Thrace, never to return to Athens.[20]

Following the removal of Alcibiades from command, Conon was assigned as commander–in–chief (strategos) in his place. As the historian Donald Kagan has argued, perhaps more importantly, the fall of Alcibiades also led to the removal from command of Thrasybulus, the highly capable commander who had been the architect of the Athenian naval victories in 411 and 410 BCE.[21] Strategically, the Battle of Notium was a victory that proved Lysander was a commander capable of defeating the Athenians at sea; conversely, it marked the end of Alcibiades's career.

After Athens' defeat at the Battle of Notium in 406 BCE, Spartan hegemony over Notion was short-lived. Athens, Thebes, Corinth, and Argos, disturbed by the growing power of the Spartans shortly after the Battle of Notium, formed a coalition against the Spartans for the Corinthian War. Ironically, the Persians supported and financed this alliance against the Spartans. As the war went against the Spartans, Sparta made a diplomatic agreement with the Persians, the Peace of Antalkidas, signed in 387/386. With this agreement, Sparta confirmed its hegemony over the Greek mainland to the Persian king, and in return, it ceded all Ionian Greek cities, including Notion, to the Persian Empire.[22] In the following years, from 387 to 334 BCE, Notion, which was part of the Lydian Satrapy, was obliged to pay tribute to the Achaemenid Empire and maintain a Persian garrison, despite having its own internal autonomy. Meanwhile, Philip II launched an expedition to Anatolia to avenge all Greek cities against the Persians and to reclaim the Ionian cities ceded to the Persians by the Peace of Antalkidas. Following Philip II's assassination, this expedition was going to be led by his son, Alexander the Great.[23] This campaign marked the end of Persian hegemony among Ionian cities, including Notion. (Fig. 10)

19. H. R. Breitenbach, "Die Seeschlacht bei Notion, 407/06," Historia 20 (1971): 152-171.
20. Meritt, Wade-Gery, and McGregor, The Athenian Tribute Lists, vol. 1.
21. Bonamente, ·La battaglia di Notion,· 199·218.; and M. Amit, "La campagne d·Ionie de 407/6 et la bataille de Notion," Grazer Beiträge 3 (1975): 1-13.
22. For a detailed modern historical evaluation of the shifting alliances during the Corinthian War and the diplomatic implications of the Peace of Antalcidas (387/386 BCE) that restored Persian hegemony over the Ionian cities, see Pierre Briant, From Cyrus to Alexander: A History of the Persian Empire (Winona Lake: Eisenbrauns, 2002); and Jack M. Balcer, Sparda by the Bitter Sea: Imperial Interaction in Western Anatolia (Chico: Scholars Press, 1984).
23. P. Debord, "Les Routes Royales en Asie Mineure Occidentale," Pallas 43 (1995): 89-97.



Figure 11. Map of Notion in the Hellenistic period. Created by the author based on Doğan (2009).

2.2.3 The Hellenistic Period (late 4th – 1st Century BCE)

The Hellenistic period marked drastic physical, demographic, and political transformations in Notion. The Western Anatolia fabric has drastically transformed by the conquest of Alexander the Great beginning in 334 BCE. The Greek city states (poleis) started a new era filled with both unprecedented opportunities and threatening dangers. Before this transformation, Notion had already experienced intense geopolitical conflicts, occupying a contested border region between the Athenian and Persian spheres of influence throughout the Classical period.

A new era for the Greek city-states (poleis) began with the end of Persian dominance in Western Anatolia through Alexander the Great's conquests. Hence, the conquest of Colophon and Notion was a political process rather than a major pitched battle. Following his victory at the Granicus, Alexander the Great aimed to weaken the Persian naval presence along the Ionian coast. He assigned his commander, Parmenion, to send away the Persian garrisons and support the democratic exiles. Consequently, the commander's forces successfully liberated both Colophon and Notion. During the late 4th century BCE, the relationship between Colophon and Notion was formalized through a *sympoliteia* (political and urban union), unifying their laws and administrative systems. [24]

The unexpected death of Alexander the Great in 323 BCE caused power conflicts among his generals, called *The Diadochi*. The destiny of the Ionian cities was shaped by the ambitious goals of Antigonus Monophthalmos, under whom Notion experienced a brief period of prosperity (311-306 BCE). However, the defeat of Antigonus at the Battle of Ipsus in 301 BCE caused a dramatic change in the political situation of Notion and the Ionian region fell to Lysimachus.[25] Around 294 BCE, Lysimachus destroyed the inland city of Colophon, in order to punish its citizens' loyalty to Antigonus. While he resettled most of the citizens of Colophon into the new capital, Ephesus forcibly exiled a significant number of citizens to the port city of Notion (Fig. 11).[26]

24. Etienne and Migeotte, Colophon et les abus des fermiers des taxes, 143-157.
25. For a detailed modern historical evaluation of the political shifts during the period of the Diadochi, specifically the brief prosperity under Antigonus Monophthalmos and the regional impact of the Battle of Ipsus (301 BCE), see Leicester B. Holland, "Colophon," Hesperia 13, no. 2 (1944): 91-95.
26. For modern archaeological and scholarly interpretations of the ancient accounts (such as those by Pausanias) regarding Lysimachus' destruction of Colophon in 294 BCE and the subsequent forced resettlement (synoikismos) of its population to Ephesus and Notion, see Ratté, Rojas, and Commito, "Notion Archaeological Survey, 2014-2015," 618-619.



Figure 12. Collage evoking the Hellenistic period leaders. Respectively, Alexander, Lysimachus, Antiochus III, Attalus I, Eumenes II. Collage by the author.

This demographic shift, though Notion resulted in an *urban refounding*. Notion became the inheritor of Colophon's population and became a significant regional center; therefore renamed *Colophon-by-the-Sea (Kolophon-epi-thalassē)*. The administration of the Sanctuary of Apollo had transferred to the city, solidifying its prestige. This administrative shift has been reflected in the urban layout of Notion. Therefore, the urban layout of Notion had been completely redesigned using a Hippodamian (grid) plan. The sloped terrain was reorganised with urban terraces, and the fortification walls were constructed. The remains of the foundations of the city's major civic and religious structures are visible today, including the Theater, Bouleuterion, Agora, Gymnasium, Temple of Athena, and Heroon. Recent archaeological surveys confirm that the city's most intensive occupation phase is often referred to as the *Long Hellenistic Period* (3rd to 1st centuries BCE), and belongs entirely to this new urban layout. Notion has remained as a contested prize among the Hellenistic kingdoms due to its strategic harbour and control over Claros. In 218 BCE, it came under the rule of Attalus I of Pergamon, who presented himself as a *Soter* (savior) of Greek liberties, though Notion ultimately lost its foreign policy independence to Pergamene expansionism. This control was interrupted in 196 BCE when the Seleucid king Antiochus III captured the city. A few years later, in 191 BCE, Notion successfully resisted a subsequent siege by Antiochus III and sided with the Attalids (Eumenes II) and the rising power of Rome (Fig.12). [27]

Loyalty of the Notion citizens to Rome and Pergamon during this conflict determined its fate. The city was rewarded at the Peace of Apamea in 188 BCE, officially granting it freedom and autonomy. However, this political independence was short-lived.[28] Following the death of the last Pergamene king, a rebellion led by the claimant Aristonicus erupted (133–129 BCE). His naval forces temporarily captured the harbor and acropolis of Notion. Once the Romans suppressed the uprising, they formally established the Province of Asia in 129 BCE. Notion was absorbed into the new Roman administrative structure, marking the definitive end of its Hellenistic autonomy and the beginning of a long, gradual decline as regional trade shifted entirely to the Roman capital of Ephesus.

27. For modern historical evaluations of the ancient accounts concerning Notion's role in the geopolitical conflicts between the Attalid and Seleucid kingdoms, its capture and subsequent siege by Antiochus III, see P. Debord, "Le pays de Colophon (Colophon, Claros, Notion) et les Séleucides," Revue des études anciennes 115, no. 1 (2013): 5-27.
28. For the modern historical analysis of Notion's autonomy following the Peace of Apamea, see John Ma, Antiochus III and the Cities of Western Asia Minor (Oxford: Oxford University Press, 1999). See also the primary ancient account in Livy, Ab Urbe Condita, 37.26.

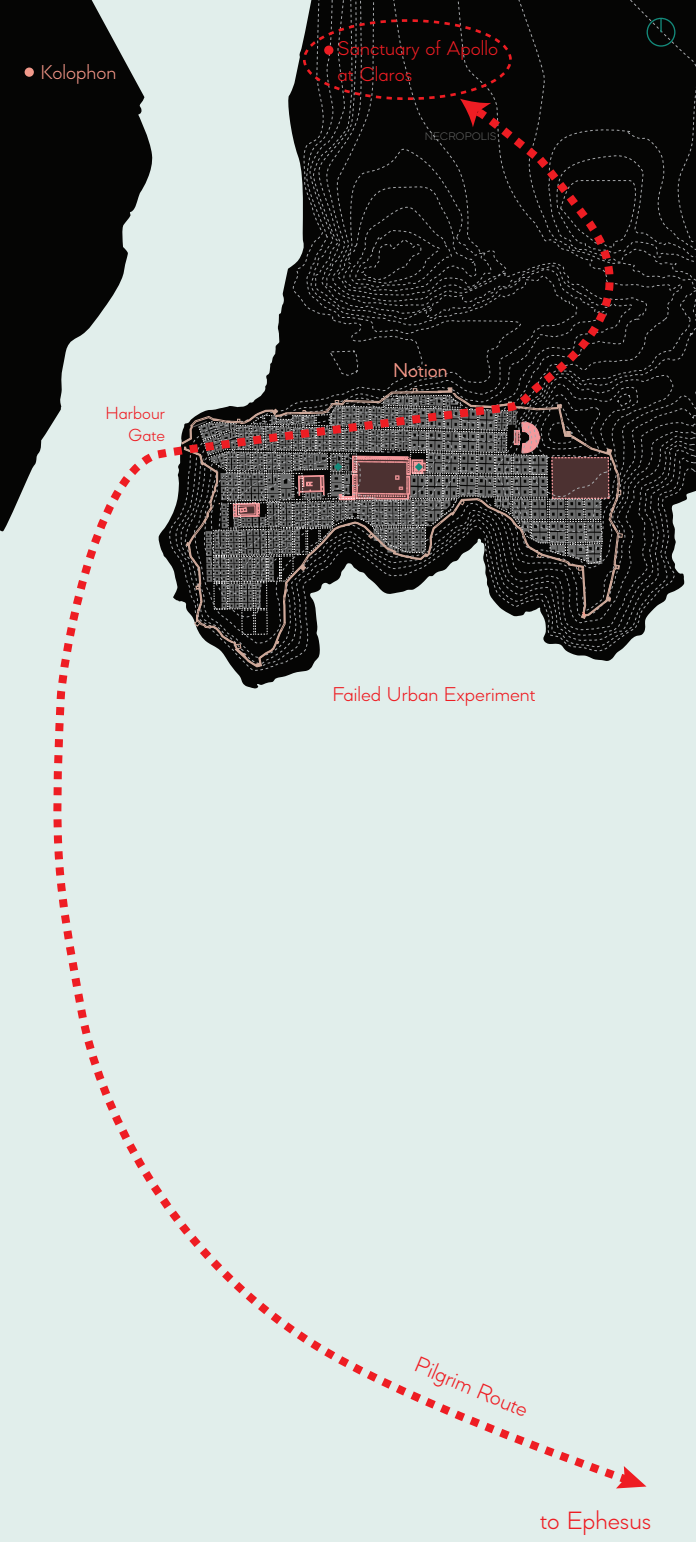


Figure 13. Map of Notion in the Hellenistic period. Created by the author based on Doğan (2009).

2.2.4 The Roman Era (1st Century BCE – 5th Century CE)

The history of Notion under Roman rule demonstrates a dramatic trajectory. Notion had a brief intense period of prosperity followed by definitive and total urban decline. During this period, the city was completely dependent on its symbiotic relationship with the Sanctuary of Apollo at Claros. While this relationship initially defines the regional importance of the city, it ultimately became the main reason for its obsolescence as the religious structures of the Mediterranean world began to change.

After the devolvement of the kingdom by the last Attalid king, Attalus III, to Rome in 133 BCE, Notion fell under Roman rule. Following the suppression of Aristonicus's rebellion, the Roman Province of Asia was established in 129 BCE. Even the epigraphic evidence remains scarce, it is widely believed that Notion was classified as a civitas stipendiaria (a tributary city). Thereby, the city was required to pay tribute to the Roman governor, even though it maintained a measure of local self-governance.[29] During the Pax Romana (around 27 BCE – 180 CE), while the neighboring city of Ephesus flourished as the undisputed commercial and administrative metropolis of the province, Notion's economy became almost exclusively reliant on its function as the coastal gateway to Claros. During the Roman Imperial period, Claros rivaled Delphi and Didyma, drawing official delegations (theoriai) and pilgrims from across the Mediterranean. To impress these arriving visitors and Roman authorities, monumental architectural investments were made. A monumental propylon (gateway) had been constructed at Claros in the late Hellenistic period, and during the imperial era, Emperor Hadrian personally promoted the completion of the sanctuary's great Doric temple. [30]

The intense religious activity caused a vibrant *pilgrim economy* in Notion. The city functioned as a logistical hub and provided some services such as accommodation, provisions, and the requirements for animal sacrifices like hecatombs. However, this prosperity was remarkably short-lived. Moreover, the most significant finding in the recent Notion Archaeological Survey conducted between 2014 and 2021 is the almost complete absence of surface pottery dating after the 1st century CE. This evidence indicates that the city had numerous investments during the Hellenistic era, and was significantly abandoned as a dense urban centre after only a few centuries of settlement. At present, the refounding of Notion has been evaluated as an urban

29. Ratté, "Archaeological Research at Notion, 2022-23," 341-342.
30. Scholarly interpretations of the primary sources concerning the oracle of Apollo at Claros, the influx of international delegations (theoriai), and Emperor Hadrian's architectural patronage of the Doric temple are thoroughly provided by J.-L. Ferrary, Les mémoriaux de délégations du sanctuaire oraculaire de Claros, d'après la documentation conservée dans le Fonds Louis Robert (Paris: De Boccard, 2014); and Rutherford, "Claros: Paideia as a Rite of Passage," 144145.

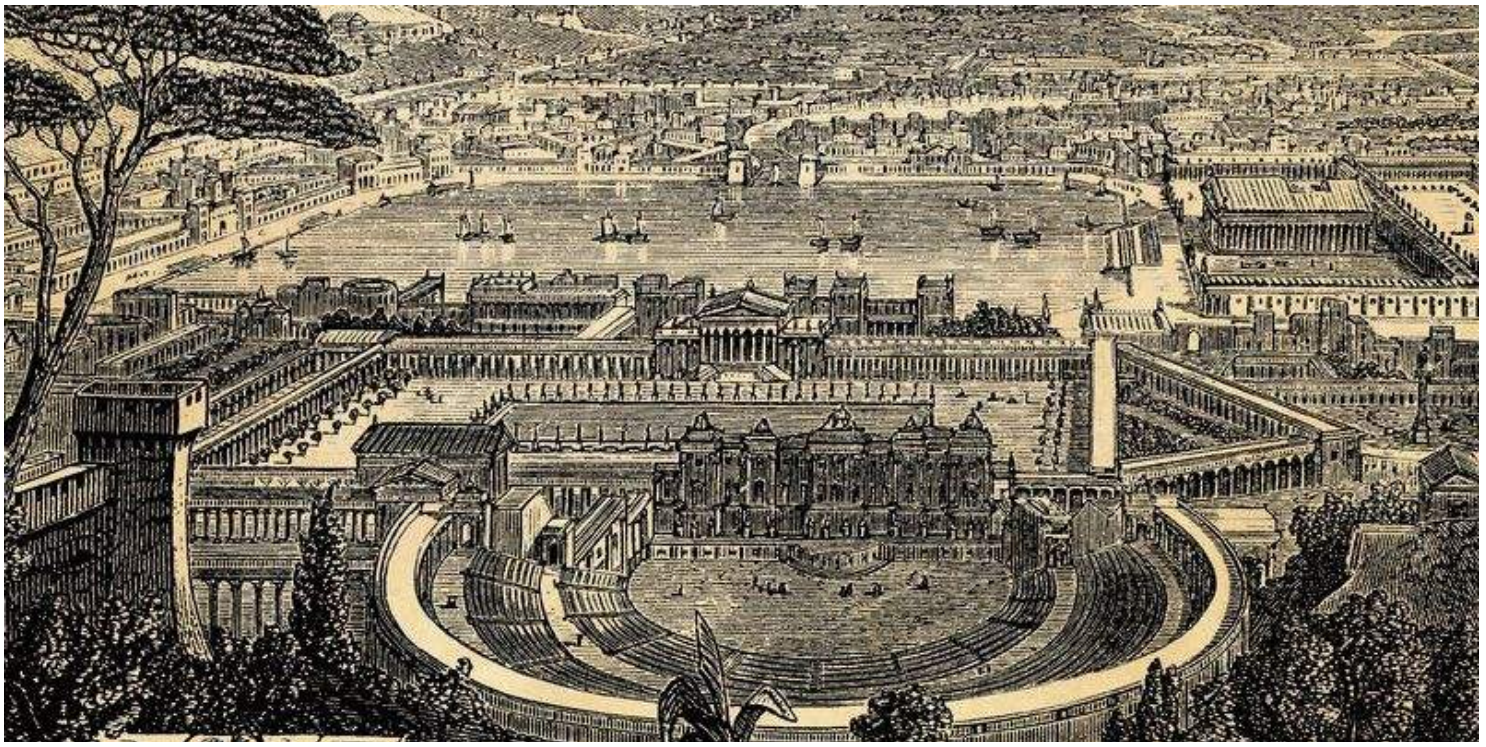


Figure 14. An illustration of the Ephesus in the Roman Era. Source : Video still from "Exploring the Ancient City of Ephesus in Turkey," Contunico © ZDF Studios GmbH, Mainz, in "Ephesus," Encyclopædia Britannica, accessed March 12, 2026,

failed experiment from the scholars' perspective; ultimately, it collapsed due to its inability to maintain a long-term population. [31]

The primary reason for Notion's rapid decline was the lack of diversity in economic activities and the overwhelming rise of Ephesus in the Ionian region. Besides, the commercial strength of the city relied solely on the Claros sanctuary, while it lacked agricultural or independent commercial activity (Fig.13). As Ephesus gained the control of the regional trade and administration, Notion lost its significance (Fig. 14) Furthermore, the Crisis of the Third Century (235–284 CE) and subsequent Gothic Invasions (circa 260 CE), heavily damaged Ionia. Since Notion had already lost its significant number of citizens by this time, the city had avoided the heavy destruction.[32]

The last impact of the existence of Notion was the establishment of Christianity and subsequently the edicts of Emperor Theodosius I during the late 4th century, which prohibited pagan rituals. Notion had completely lost its functional purpose after the official closure of the Sanctuary of Claros around 395 CE. However, the city has been transformed into an administrative title from a living city. Although the name survived within the Christian Church hierarchy, and appeared under the title of the *Bishopric of Kolophon* in the Late Roman inscriptions; and also its minimal representation of the name at the Great Ecumenical Councils of the 5th century proved its drastically reduced status. By the 5th century, Notion was not functioning as a living city; hence its name was solely represented as a minor ecclesiastical authority over a vast abandoned archaeological landscape. [33]

31. Recent archaeological surveys provide extensive documentation regarding the striking absence of post-first-century CE surface pottery at Notion, leading scholars to characterize its Hellenistic refounding as a "failed urban experiment." See Ratté, Rojas, and Commito, "Notion Archaeological Survey, 2014-2015," 625-626.
32. The economic marginalization of minor Ionian cities due to the overwhelming rise of Ephesus under Roman imperial administration, as well as the regional impacts of the third-century crises, are thoroughly analyzed in current historical literature. See Ratté, "Archaeological Research at Notion, 2022-23," 341-342.
33. Detailed examinations of the late antique ecclesiastical records, which confirm the minimal presence of the Bishop of Colophon at the 5th-century Ecumenical Councils despite the physical abandonment of the city, can be found in R. Price and M. Gaddis, eds., The Acts of the Council of Chalcedon, Translated Texts for Historians 45, Vol. 1 (Liverpool: Liverpool University Press, 2007), 298, 336; see also Ratté, Rojas, and Commito, "Notion Archaeological Survey, 2014-2015," 620.

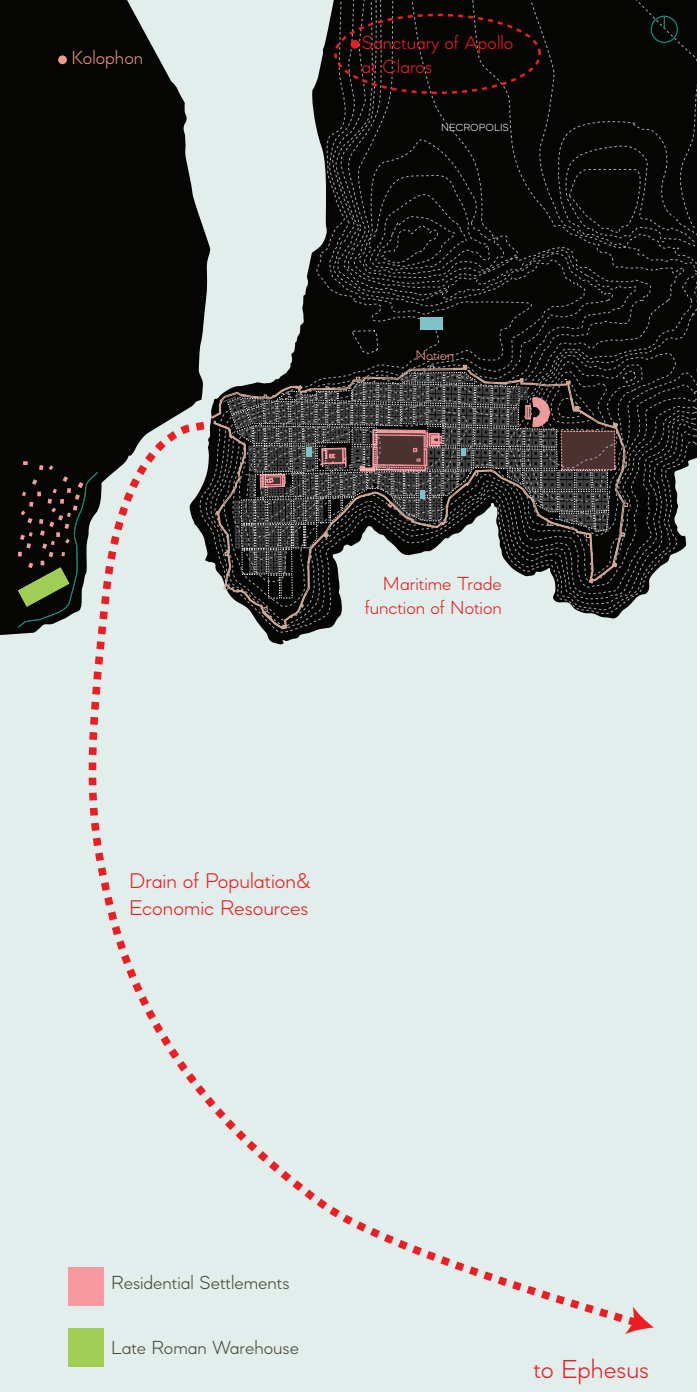


Figure 16. Map of Notion in Late Antiquity and the Byzantine period.
Created by the author based on Doğan (2009).

2.2.5 Late Antiquity and the Byzantine Period (5th – 14th Century)

The Late Antiquity of Notion was a remarkable urban and demographical transition phase. During this transitional phase, Roma had supported Ephesus by assigning it as a capital of the province. The explosive growth of Ephesus drew in the population and economic resources that had once sustained smaller coastal cities in the region. Due to its powerful neighbor, Notion gradually lost its former civic importance. This historical trajectory could be also seen in the extensive archaeological survey conducted between 2014 and 2021 revealed an absence of pottery dating after the 1st century CE within the primary residential areas of the city. However, these findings suggest that the massive Hellenistic urban grid on the acropolis was largely depopulated and abandoned by the early Roman Imperial period.

However, recent excavations conducted in 2023 and 2024 near the ancient harbour at the mouth of Hales River, revealed the foundations of a Late Roman warehouse complex. Thic foundation dates back to 5th and 6th centuries CE, the excavated portion of the structure has dimensions at least 26 m by 12 meters. The plenty of Late Roman Amphorae (LRA 3) recovered from this structure, demonstrates that the harbour of Notion remained as a maritime commercial hub long after the residential settlements of the acropolis had been abandoned (Fig. 16).

Besides its maritime commercial activity, it was also functioning as an ecclesiastical presence during the Late Antique and Byzantine eras. The bishop of Colophon was effectively shifted to Notion and participated to the First Council of Ephesus in 431 CE. Within the fortification walls of the city, it had documented that the remains of two or possibly three apsidal structures constructed by using mortared rubble masonry, which is the characteristic of the Late Antique and Byzantine church architecture. Moreover, a three-aisled basilica located approximately 500 meters north of the fortifications, was found in the early 20th century. This episcopal church had a an inscribed architrave with the name of a bishop and the date 1060 CE. Therefore, this epigraphic evidence indicates that the bishopric in the site was not only a titular administrative holder, also was an active religious center that sustained a Christian community during the Byzantine period.[34]

Following this phase, the site was completely abandoned. Unlike the other ancient settlements that were constantly re-inhabited, the site of Notion was significantly left forgotten.

34. Th. Macridy, "Altertümer von Notion I," Jahreshefte des Österreichischen Archäologischen Institutes in Wien 8 (1905): 155-173. For the 5th-century ecclesiastical records, see R. Price and M. Gaddis, eds., The Acts of the Council of Chalcedon, Vol. 1 (Liverpool: Liverpool University Press, 2007), 298.



Figure 17. Aerial view of the Notion archaeological site, looking northeast, with the Hales River to the west. Source: Notion Archaeological Survey, University of Michigan, accessed December 2025.

2.2.6 The Ottoman Era and Modern Period (14th - 21st Century)

Following the definitive abandonment of the city after the Byzantine period, the site had remained without a settlement. Despite the current physical desolation of the ancient city, the surrounding settlements had a sparse demographic fabric (Fig. 17). A significant amount of the population in the region remained Greek origin until the establishment of the Republic of Turkiye in 1923. Therefore, the ruin of Notion and the adjacent settlement were recalled in the Muslim community as *Gâvurköy* (Village of the Infidel), a nomenclature representing the local memory of the Notion regarding its Pagan and Christian past.

Remarkably, the local Greek community living in the area continued to utilize the necropolis of Notion ancient city as their own burial grounds.[35] Today, the ancient city is located in Ahmetbeyli in the Menderes district of Izmir. The site of city remained as archaeological landscape where the ruins and the natural ecosystem exist in symbiotic relationship (Fig. 18). However, the rugged terrain of Notion serving as an open-access, unregulated site, attracting the hikers. Currently, systematic excavations are being conducted under the authorization of the Turkish Ministry of Culture and Tourism.

35. Ergün Laflı, "Notion'dan Yeni Buluntular," Güncel Sanat (June 2015): 11.

Historical Evolution of the Ionian Region and Turkiye

2500 BC



1500 BC



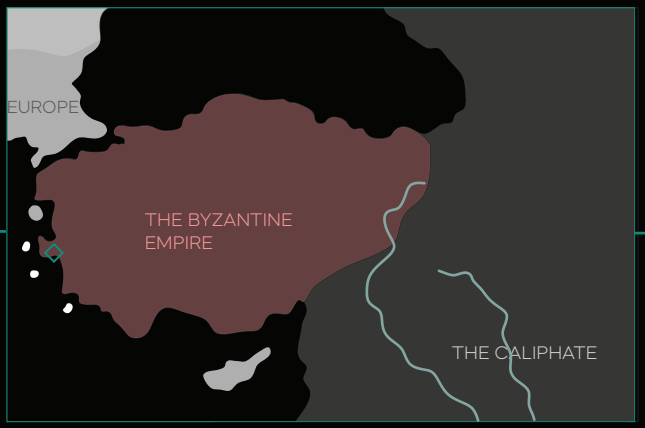
200 BC



30 BC



750 AC



979 AC



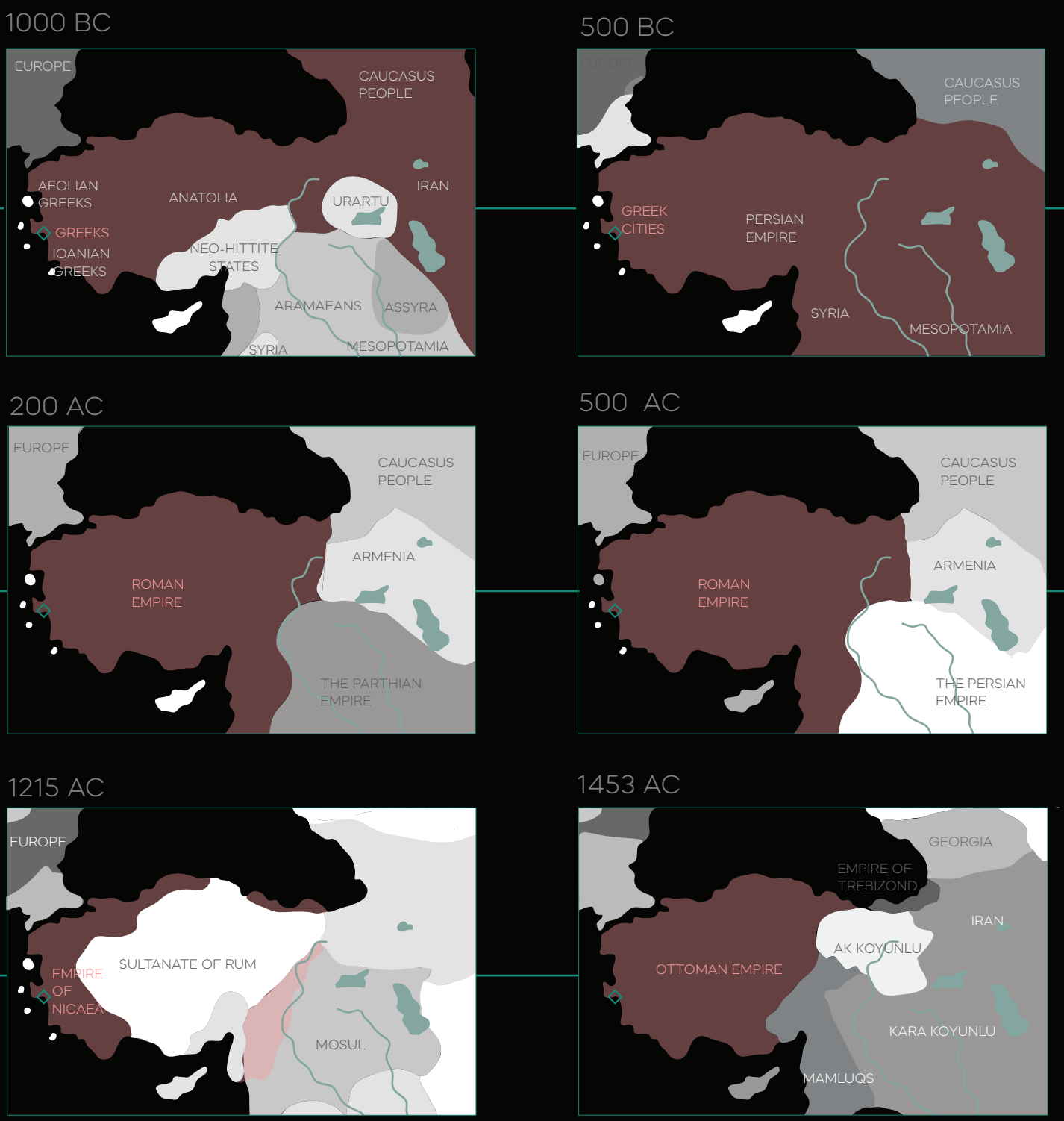


Figure 18. Timeline of historical evolution of political territories in the Ionian region and Türkiye, 2500 BCE–1453 AC. Map by author, based on Talbert (2000), McEvedy (2002), and McEvedy (1992)

2.3 Archaeological History

The archaeological history of Notion Ancient City is a long process initiated in the 19th century and includes excavations conducted with modern systematic methods. The first research on the site was conducted by German archaeologist Carl Schuchhardt in 1886. Subsequently, the Ottoman historian Theodor Macridy and the French historian Charles Picard conducted investigations in 1897, 1904, and 1913, focused on the necropolis and a Byzantine church. However, the first systematic excavations carried out in 1921 by Robert Demangel and Alfred Laumonier from the French School of Athens initially uncovered the Temple of Athena, which was situated on the western promontory of the ancient city.[36]
After a long time, the archaeological interest was revived by the campaigns of targeted rescue excavations of the Turkish team. The first of these team was led by Erol Atalay and excavated the theater and northern necropolis area between 1985 and 1986. Later, in 1994, Mustafa Büyükkolancı led another excavation campaign to uncover the Bouleuterion (council house), the Heroon (which is alternatively identified by some scholars as the Apollo Temple), and an entrance in the northern fortification walls. The modern phase of surface research into the ancient city began with the Notion Archaeological Survey, executed between 2014 and 2018 by the University of Michigan and Brown University (Fig 19). The survey was conducted with comprehensive modern techniques to document the surface collections.

Regarding the survey results, which were launched by the University of Michigan in collaboration with Sinop and Aydin Adnan Menderes Universities. These ongoing excavations aim to investigate civic buildings, such as the Bouleuterion and the Hellenistic peristyle house.

Recent excavation campaigns have yielded new discoveries related to the city's historical biography; among the findings, the most notable is a late 5th-century BCE hoard of Persian gold coins called *darics* found beneath the Hellenistic courtyard and a Late Roman warehouse near the ancient harbour, which points out that maritime commerce remained long after the residential acropolis was depopulated. [37]

36. Demangel & Laumonier "Fouilles de Notion (1921)," Bulletin de Correspondance Hellénique 47 (1923): 355.
37. Ratté, ·Archaeological Research at Notion, 2022·23,· 341-342.



Figure 19. Archaeologists at work at Notion. Photograph courtesy of the Notion Archaeological Project, University of Michigan.

Timeline of Archaeological Research



1886-1887

Carl Schuchhardt and H. Kiepert

He produced the first topographic map and detailed city plan of Notion. He published the initial archaeological investigations of the ruins, documenting the visible layout of the city and its territorial scale.

1897-1913

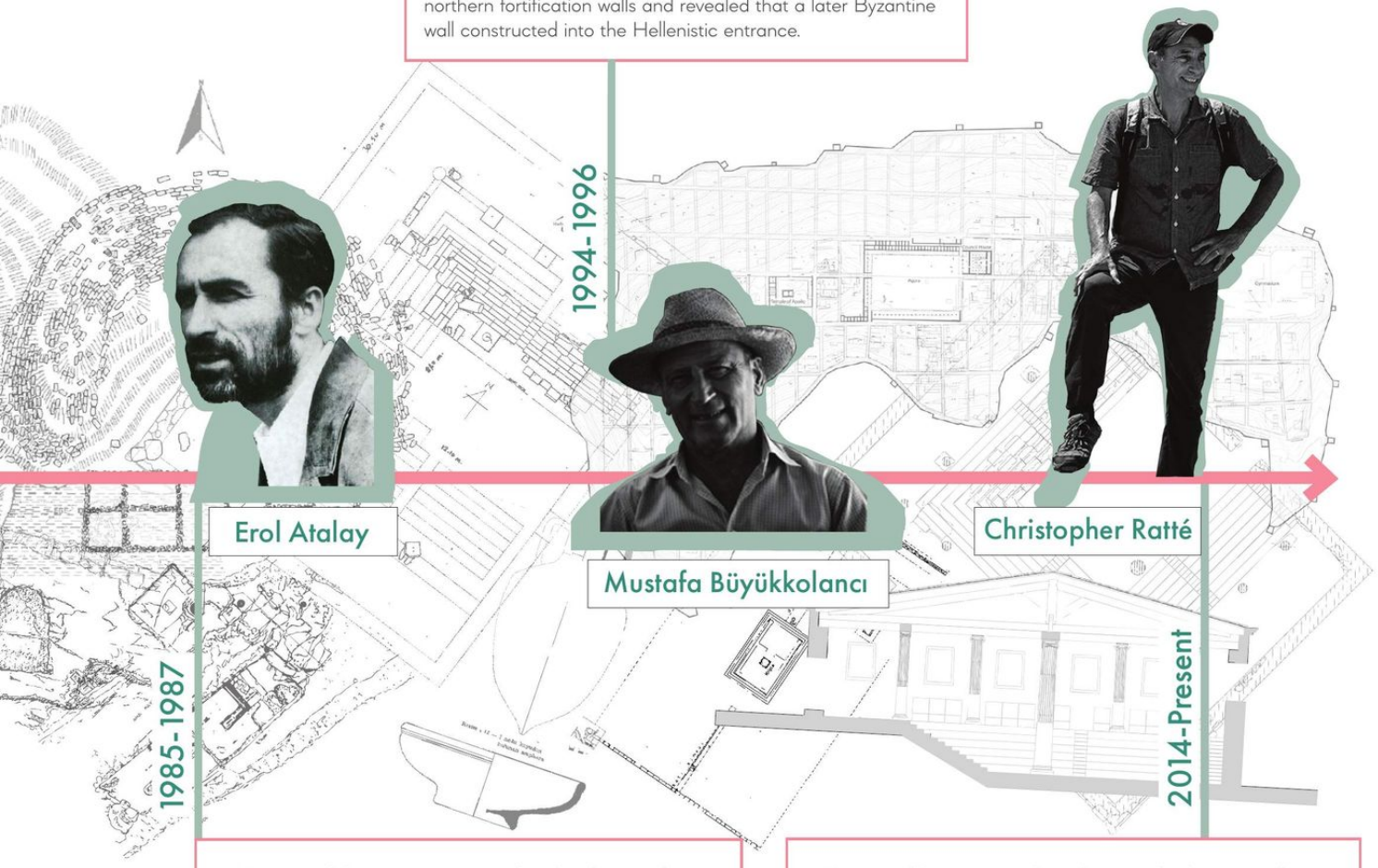
Theodor Macridy

The earliest excavations conducted at Notion, primarily focusing on the city's necropolis and Byzantine church. He discovered the cut-tombs and grave stelae along the Hales River valley; also important epigraphic inscriptions.

1921-1925

Robert Demangel and Alfred Laumonier

He systematically excavated the Temple of Athena on the western promontory of the city. Recovered precious artifacts from sanctuary, including marble statuettes, bronze bone, glass and silver objects.



Büyükkolancı excavated civic and religious structures in the acropolis, including the Bouleuterion and Heroon with its internal organizations. Besides, he also investigated the northern fortification walls and revealed that a later Byzantine wall constructed into the Hellenistic entrance.

He initiated the operations regarding the cleaning the dense vegetation of the theater; and also documented the structural vulnerabilities related to the displacements in the cavea.
He discovered the evidence regarding the domestic reuse of the necropolis area, demonstrating how the rock.cut tombs were modified into residential spaces during the Roman Period.

Ratté and his team conducted a comphrehensive surface survey in the first phase of the investigation , utilizing the aerial photograpmmetry in order to map the subterranean streets and urbanlayout.
The second phase of the survey which includes the systematic excavations in 2022, focusing on the Bouleuterion, Hellenistic peristyle house on the West Ridge and a Late Roman House close to the harbour gate.

2.3.1 Carl Schuchhardt and H. Kiepert (1885–1886)

Until the late 19th century, aside from the ancient Ionian cities of Colophon and Notion, the precise location of the Sanctuary of Apollo at Claros was the subject of debate among scholars and travellers. Early European travellers to the region, such as Richard Chandler and Charles Texier, had misidentified the prominent coastal visible ruins of *Temple of Athena* near the Hales River as the *Oracle Centre of Claros*. Consequently, the exact location of the port city of Notion remained undefined in early modern scholarship.[38]

The archaeological history of Notion reached a turning point with the expeditions of German geographer and cartographer Heinrich Kiepert and the archaeologist Carl Schuchhardt. However, Kiepert began an initial topographical expedition from Ephesus, passing through the mountains into the Hales River Valley to seek the lost city of Colophon. Although Kiepert's preliminary journey did not definitively define the location of the inland city of Colophon, his surveys provided such crucial geographical groundwork that they established a foundation for subsequent studies in the region (Fig. 21).[39]

Thereafter, between January 5 and 12, Carl Schuchhardt, accompanied by archaeologist Paul Wolters, conducted a systematic following expedition to re-examine the ruins in the region. Schuchhardt's research provided guidance on correcting the significant mistakes made by earlier investigators. Moreover, he demonstrated that the remains on the two promontories overlooking the sea at *Gavurköy Kalesi* did not belong to Claros Ancient City, but the ancient port city of Notion. Schuchhardt correctly noted that a coastal fortress with a harbour alongside the river could only be a Notion ancient city. During the same expedition, he identified the inland ruins at Tratscha as Colophon, additionally with the assistance of a local priest, discovered the correct location of the Sanctuary of Apollo at Claros in a secluded valley between Colophon and Notion.[40]

In addition to identifying the site, Schuchhardt produced the first comprehensive archaeological description regarding the Notion's urban fabric. He documented the 3 kilometer long Hellenistic fortification walls and distinguished the construction phases including later Roman repairs utilising mortar and spolia. Furthermore he also detailed the city's internal layout of the city, including the Temple of Athena on western promontory, a structure as he classified as a Bouleuterion or Dikasterion, the theater on the eastern side, and the extensive rock-cut necropolis on the northern slopes.

The main achievement of these expeditions was the production of a highly accurate regional map of the *Colophon-Notion-Claros triangle*. However, published in 1886, this map was based on on-site observations and topographical surveys previously conducted by Heinrich Kiepert and drawn by Schuchhardt (Fig. 22). Their collaboration established the true identity of Notion Ancient City and provided the essential topographical framework that informed all subsequent archaeological research at the site.[41]

38. Holland, "Colophon, 93, Schuchhardt, Kolophon, Notion und Klaros,398-399.
39. Schuchhardt, "Kolophon, Notion und Klaros," 400-401.
40. Schuchhardt, "Kolophon, Notion und Klaros", 399-400.
41. Schuchhardt, "Kolophon, Notion und Klaros", 399,401-403,429.

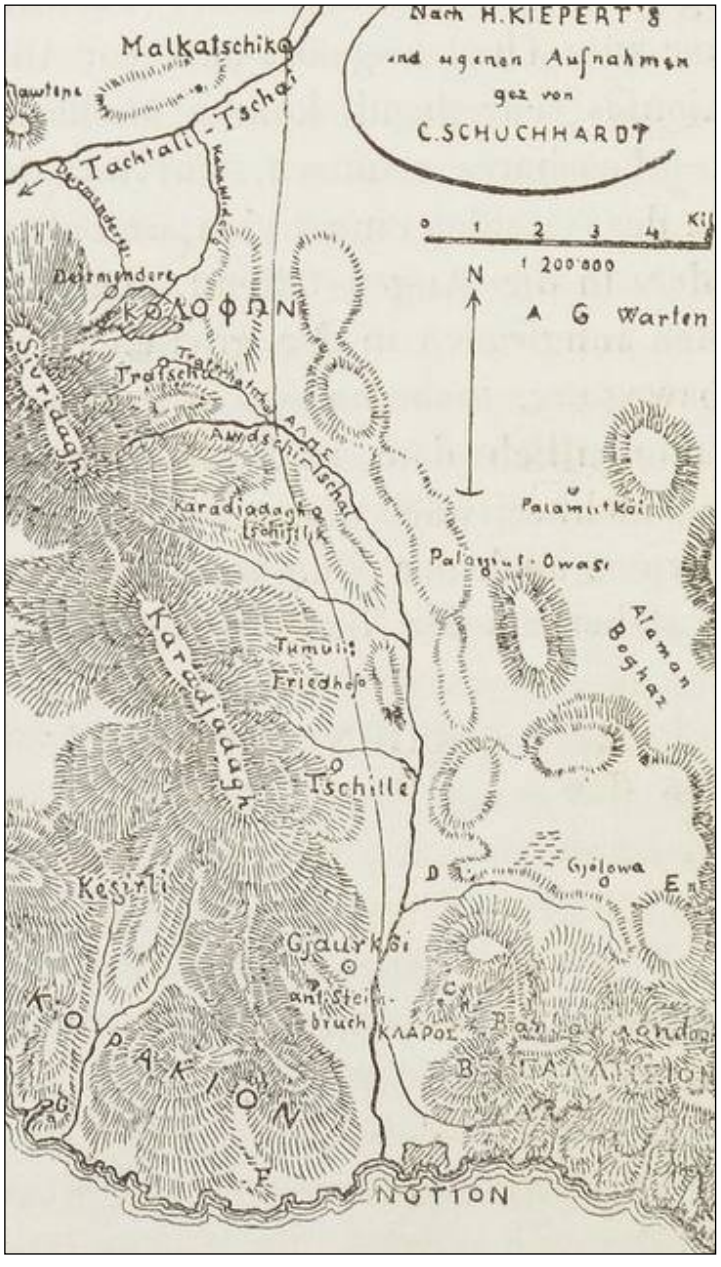


Figure 21. Early survey maps and plans of Notion, Kolophon, and Klaros. Source: Schuchhardt (1886), 398–434.

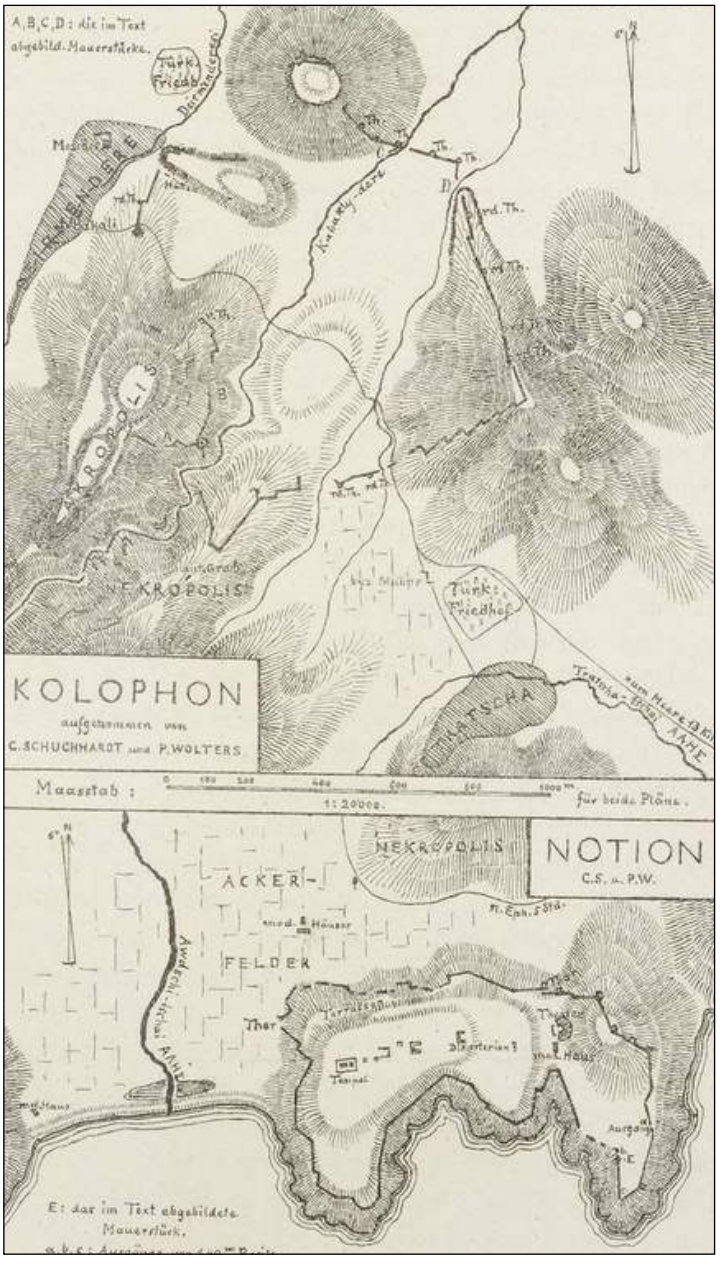


Figure 22. Plan of the city ruins of Notion. Source: Schuchhardt (1886), Table 1.

2.3.2 Theodore Macridy (1897–1913)

The archaeological investigation of the ancient city of Notion was significantly shaped by the pioneering works of the Ottoman-Greek scholar Theodore Macridy. Macridy began his research at Notion and its neighbouring sites, Claros and Colophon, in 1897, collaborating with the French scholar Charles Picard. He subsequently returned to Notion to conduct further excavations in 1904, 1910 and 1913. The 1910 and 1913 campaigns continued for the Müze-i Hümayun (the Imperial Museum) in Istanbul.[42] During these subsequent campaigns, Macridy explored the Classical and Hellenistic structures of the city and made important epigraphic discoveries. Such as in 1904, he uncovered an inscription that gave reference to two distinct *gymnasia* at Notion; however, one of them was dedicated to the *neoi* and the other to *epheboi*.

Beyond his significant contributions regarding the Greco-Roman period, the study of Macridy played a pivotal role for illuminating Notion's Late Antique and Byzantine history. Specifically, it is essential to mention that he discovered a large three-aisled basilica located approximately 500 meters north-northwest of the fortification walls. This structure has measures of roughly 35 by 14 meters and features a sanctuary with three distinct apses, with a central apse spanning 5.55 meters in diameter. During the excavations within the apse revealed some steps leading to a small subterranean well, which was defined as "potential holy water spring" (*hagiasma*) by Macridy. Additionally, evidence of further staircases connecting to the main apse and narthex indicated the presence of upper galleries overlooking the side aisles (Fig. 23). This investigation also includes the findings in the religious complex, such as Early Christian ambo, as well as mosaic floor situated 0.75 meter below the later medieval pavement of the church (Fig. 24).[43]

He also identified an architrave, which has a dedicatory inscription naming a bishop and providing the precise date of 1060 CE. However, this epigraphic evidence demonstrates that the basilica underwent at least two major phases and that the bishopric of Notion maintained an active Christian community into the Middle Byzantine period. However, Macridy systematically published his findings and detailed observations in academic journals, particularly in 1905 and 1912. Therefore, by documenting architectural and sculptural discoveries prior to the site being subjected to modern excavations, Macridy's comprehensive surveys had established the base for all subsequent archaeological research at Notion.[44]

42. Christina DiFabio, "Past and Present Research at Notion, Turkey: Using Museum and Archival Material to Contextualize New Results," AIA Annual Meeting (2019), 6-7;Ioannis N. Grigoriadis, "Developing Archaeology and Museology in the Ottoman Empire, Turkey, and Greece: Théodore Macridy, an Ottoman Greek ·Liminal Scientist·," European Journal of Archaeology (2022): 7-9.
43. Macridy, "Altertümer von Notion," 157; Ratté, "Notion Archaeological Survey, 2014," 4-5.
44. Th. Macridy, "Antiquités de Notion II," Jahreshefte des Österreichischen Archäologischen Institutes in Wien 15 (1912): 36-67; Grigoriadis, "Developing Archaeology and Museology", 7-9.

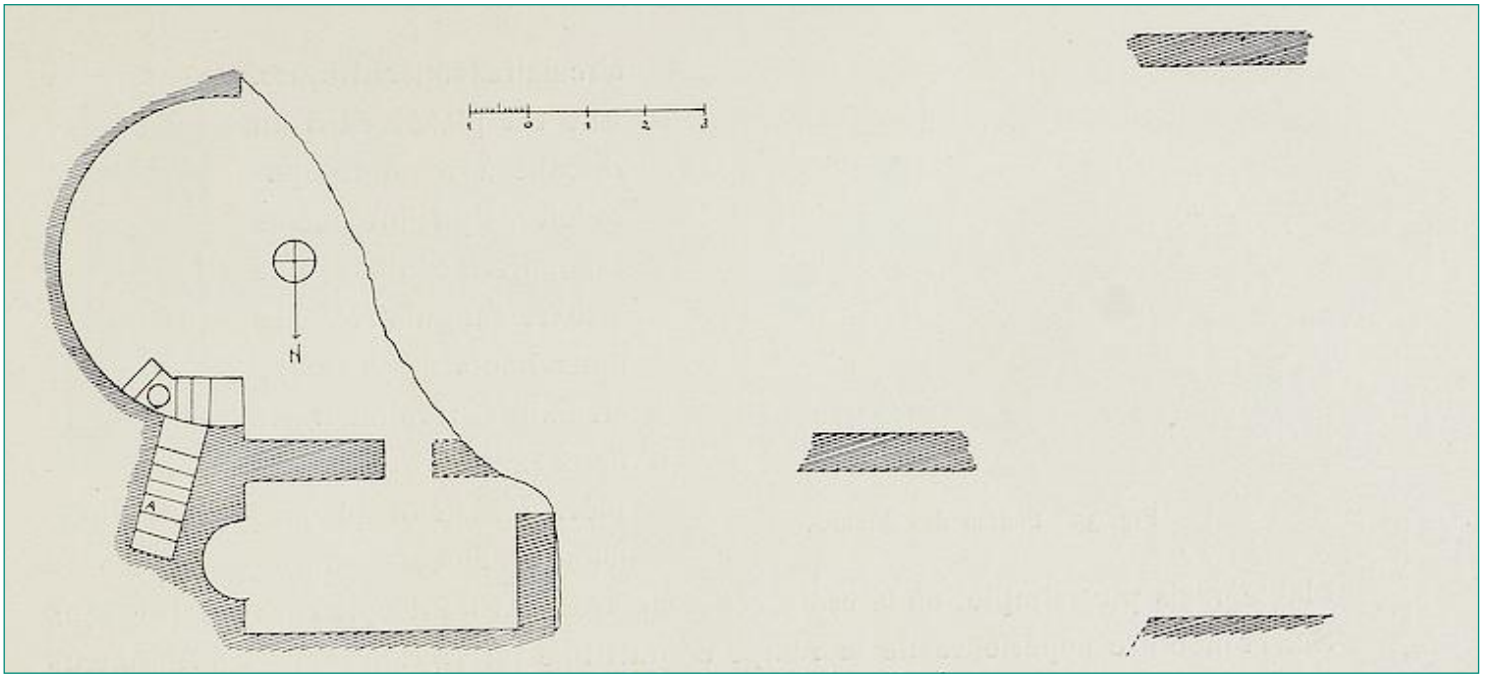


Figure 23. Ground plan of the Byzantine basilica at Notion. Source: Macridy (1905), 157, fig. 36.

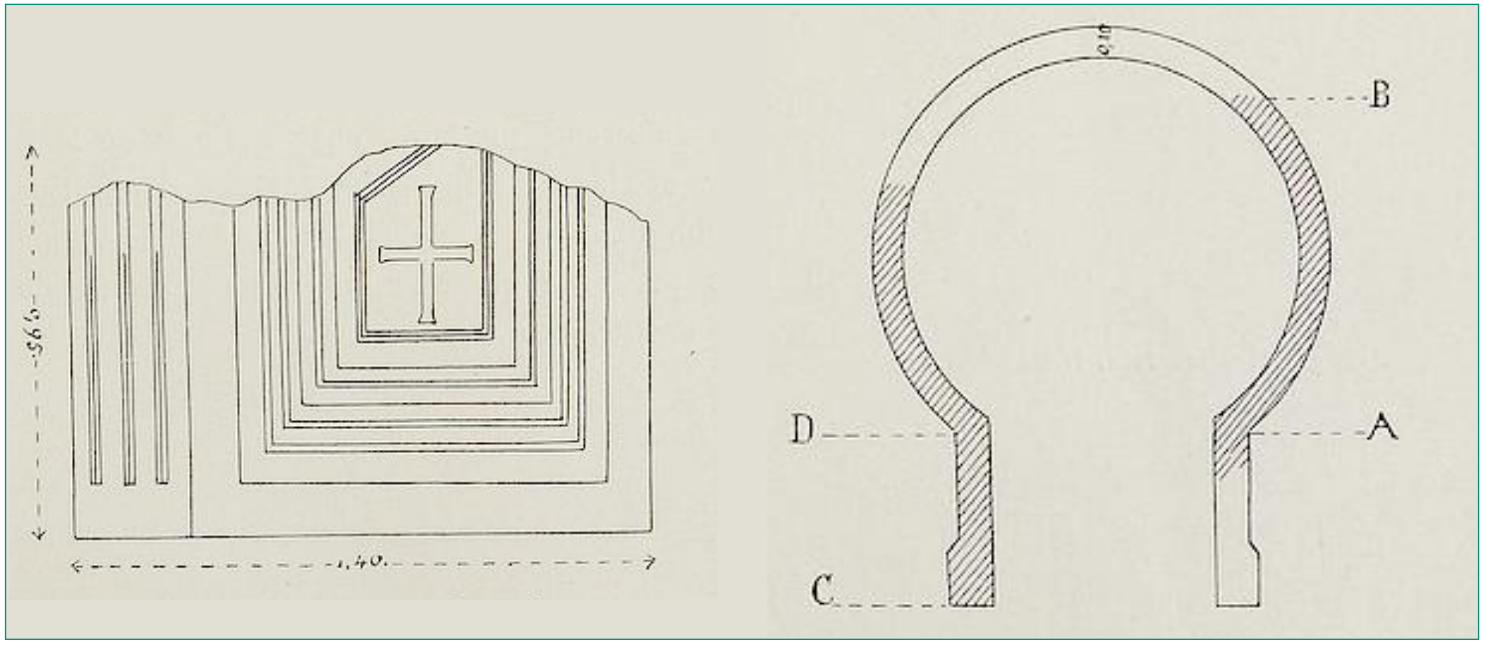


Figure 24. Architectural details and ground plan of the Early Christian ambo discovered in the basilica. Source: Macridy (1905), 157, figs. 37–38.

2.3.3 Robert Demangel and Alfred Laumonier (1921 – 1925)

The first systematic excavations were conducted under unstable political conditions. The French School at Athens initiated official fieldwork at the site during the Greek military occupation of western Anatolia after World War I. The excavation was authorised by Konstantinos Kourouniotes who is a Greek inspector of antiquities in Smyrna, on March 24, 1921. However, the fieldwork by Demangel and Laumonier was conducted in late summer 1921, and institutional support by Charles Picard, director of the French School.[45]

The team exclusively on the highest point of the western promontory, concentrating on Temple of Athena. The foundation of Temple of Athena had uncovered successfully. The French team employed a drastic archaeological methodology; they dismantled later structure situated southwest of the temple in order to recover the marble blocks. This structure was identified as *Byzantine Tower* noting that nearly all of the original marble blocks of the ancient temple had been reused as *spolia* in the construction of tower (Fig.25). After dismantling the tower, the team placed the recovered blocks around the templed foundations; such process enables the recognize the temple as Corinthian distyle in antis temple and recovered significant decorative elements, including a garland frieze with bucrania (Fig. 26). Even Demangel and Laumonier defined that these findings date back to the Hadrianic Period based on their stylistic analysis; the contemporary studies redated the construction phase of the findings as the Hellenistic or Augustan period. This excavation also discovered the surrounding porticos; behind the western portico, the team discovered a series of small storerooms filled with artifacts, including large quantities of terracotta figurines, various types of Roman lamps, stamped roof tiles, and coins minted in Ephesus and Colophon.[46]

However, in September 1921, Demangel and Laumonier had classified their findings as the ones considered *precious* such as bronze, bone, glass and silver objects, as well as fine marble statuettes, were sent to Smyrna for safekeeping under the Greek archaeological service. The remaining bulkier items were left in the nearby village of Giaour-Koy (Gavurköy), modern Ahmetbeyli, to a local guard named Andrikos Hadjiphotiou.[47]

After the withdrawal of Greek forces and the Great Fire of Smyrna in September 1922, the French team was permanently unable to return to the site to resume its investigations on-site. They published the preliminary findings and catalogue of approximately 150 objects in the *Bulletin de Correspondance Hellénique* in 1923 and 1925. Due to the interruption of the project, a comprehensive final publication was never produced. Furthermore, historical archives indicate that the team themself never able to learn whether their precious artifacts survived the catastrophic fire in Smyrna, resulting in a permanent gap in the historical record of the city. Consequently, contemporary scholarship does not classify these artefacts as systematically smuggled from the region; rather they represented undocumented losses directly resulting from the wartime evacuation and the following conflagration in Smyrna. However, during the great Smyrna fire, it is important to clarify that the ancient city has not damaged by the fire, while the portable remains affected. Nonetheless, addressing modern natural fire risks should be considered as a priority for current heritage management at the site, requiring systematic control and maintenance.[48]

45. DiFabio, "Past and Present Research at Notion", slide 21.
46. Robert Demangel and Alfred Laumonier, "Fouilles de Notion (1921)," Bulletin de Correspondance Hellénique 47 (1923): 363; Christopher Ratté, Felipe Rojas, and Angela Commito, "Notion Archaeological Survey 2017-2018" (University of Michigan, 2018), 4.
47. DiFabio, "Past and Present Research at Notion," slides 21-22.
48. Demangel & Laumonier, "Fouilles de Notion (1921)," 360.



Figure 25. The "Byzantine tower" at the southwest corner of the Temple of Athena prior to its demolition. Source: Demangel and Laumonier (1923), 363, fig. 9.

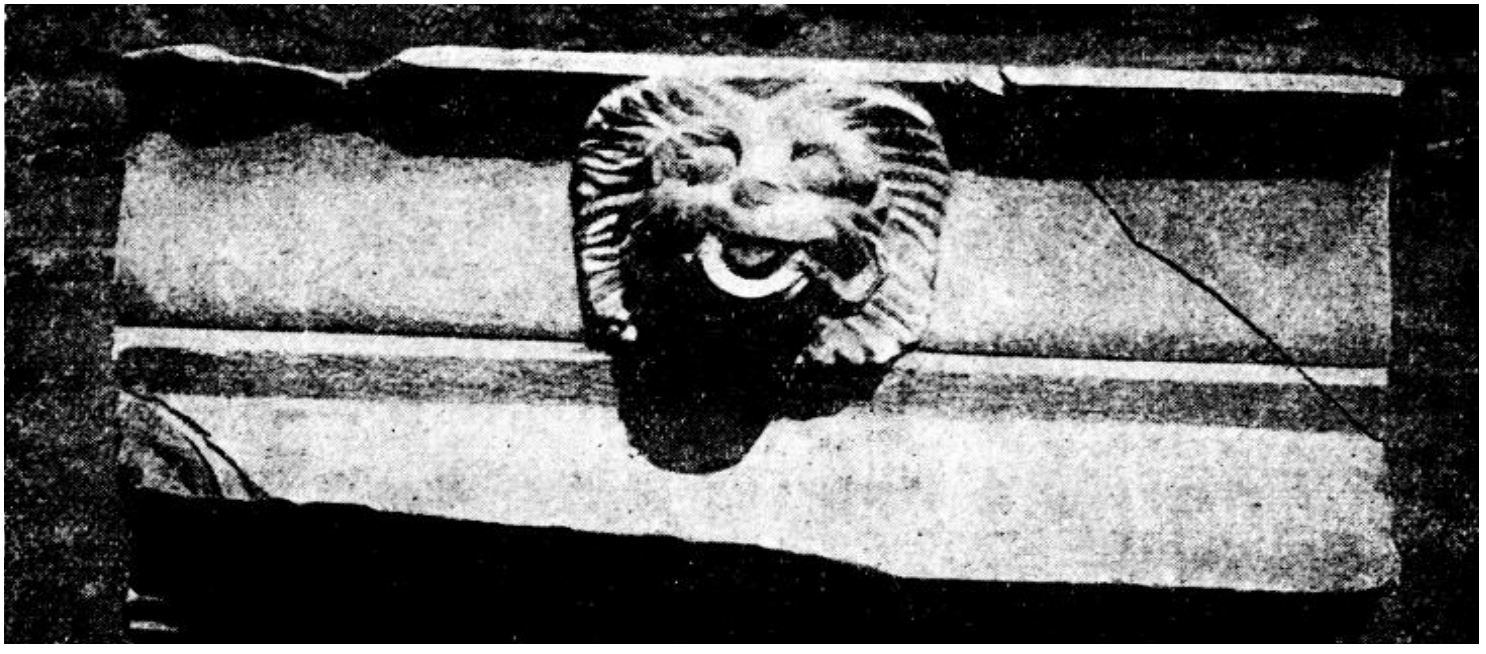


Figure 26. Frieze block from the Temple of Athena decorated with garlands and bucrania. Source: Demangel and Laumonier (1923), 370, fig. 15.

2.3.4 Erol Atalay (1985–1987)

Prof. Erol Atalay launched his excavation campaign in July 1985, following the interruption of the French expedition in 1921; as a result, the ancient city had remained unstudied for more than sixty years.[49] His excavations and studies were executed across three seasons, in 1985, 1986, and 1987.[50]

During Atalay's campaigns, he primarily focused on Hellenistic funerary and burial customs. His team's excavation focused on the eastern necropolis situated in the Hales River valley, between Notion and Claros. There, his team successfully excavated three rock-cut tombs. In order to document the architectural characteristics of these funerary findings, Atalay's team produced detailed elevation drawings, including the facade plans of tombs No. 2 and No. 3 (Fig 27).

Furthermore, in front of one of these tombs, he discovered a significant and well-preserved grave stele belonging to an athlete named Eudokimos. Additionally, he also documented numerous other inscribed and sculpted grave stelae from the Hellenistic and Roman periods. The most remarkable example of this documentation is a Hellenistic grave stele depicting a farewell scene, dated to the middle of the 2nd century BCE. However, the stele was found severely damaged, with the upper torso and facial features missing. The relief illustrates a young girl, a servant, and another female servant depicted partially on the left (Fig 28). These findings provide a comprehensive knowledge regarding the burial traditions of Notion's inhabitants.

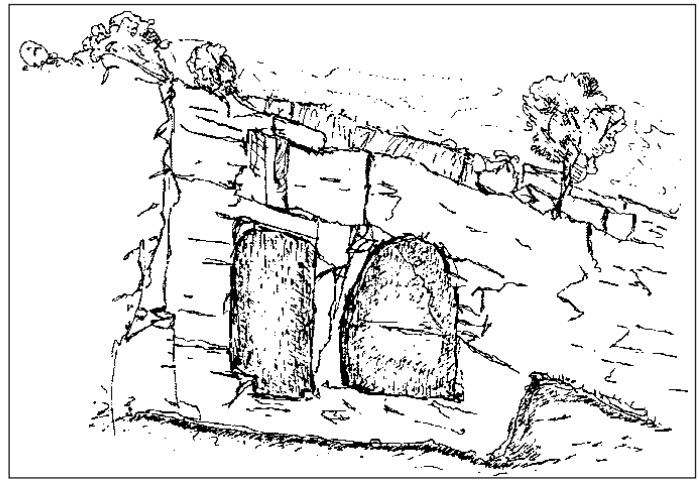


Figure 27. Architectural elevation drawing of rock-cut tombs No. 2 and 3, eastern necropolis. Source: Atalay (1987), 153, resim 5.

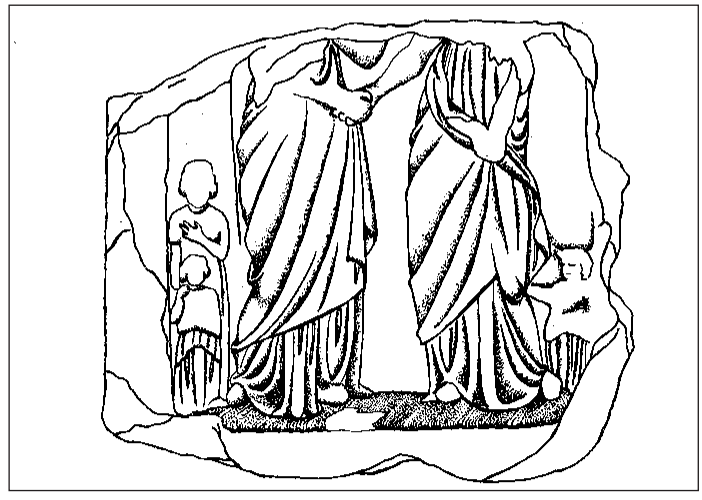


Figure 28. Hellenistic grave stele depicting a farewell scene, necropolis of Notion. Source: Atalay (1986), 88, resim 12–13.

49. Atalay, "1985 Yılı Notion Kazıları," 69; Ö. Özyiğit, "Büyük Kaybımız Doç. Dr. Erol Atalay," Nekroloji (1988): 971.
50. Özyiğit, "Büyük Kaybımız Doç. Dr. Erol Atalay," 971.

Moreover, Prof. Atalay produced geographical scale maps to provide a comprehensive understanding of the distribution of the funerary monuments within the landscape of Notion. His team prepared a topographic map of the ancient city and its necropolis, which became a fundamental tool for their systematic site investigations, illustrating the contour lines and steep slopes that characterize the challenging natural terrain of the city (Fig 29).

The maps detailed the exact location of the eastern necropolis and the acropolis of Notion along the Hales River, and also demonstrated how the ancient inhabitants utilized the rugged topography for their burial practices. This mapping effort also provided the geographical framework that the excavation team utilized to pinpoint the locations of their targeted investigation points on the site.

This means the team could systematically trace the transition from the necropolis to the public monuments situated on the city's eastern hills by the mapping contours from valley floor up to the central structures of Notion. In the following investigations, Atalay had shifted his focus towards to the prominent civic structures integrated to the inclined terrains (Fig 30).

Beyond these significant discoveries in the necropolis, Atalay initiated investigations at the theater during his 1985 and 1986 campaigns. These investigations began with architectural drawings defining the theater's plan and the elevation of the diazoma (Fig. 31, 32, 33, 34). His team also conducted clearing operations regarding the dense vegetations and mentioned that the tree roots that severely dislocate the cavea seating blocks, causing them to roll down from the slope (Fig. 35).

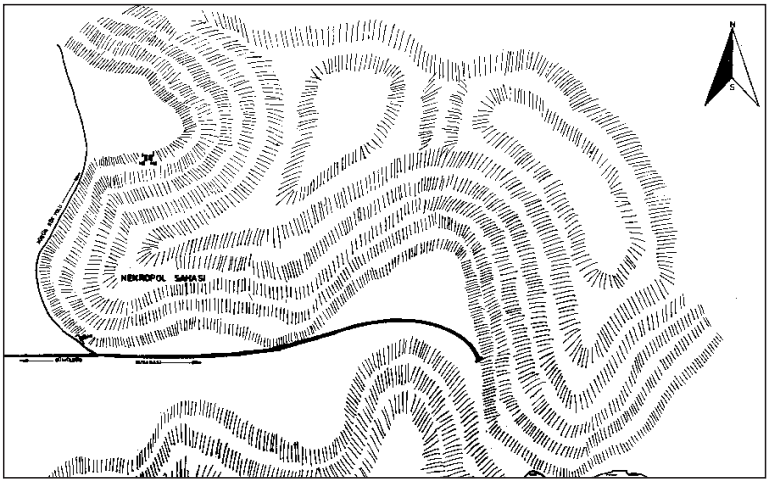


Figure 29. Topographic plan of Notion showing contour lines and excavation areas. Source: Atalay (1986), 83, plan 8.

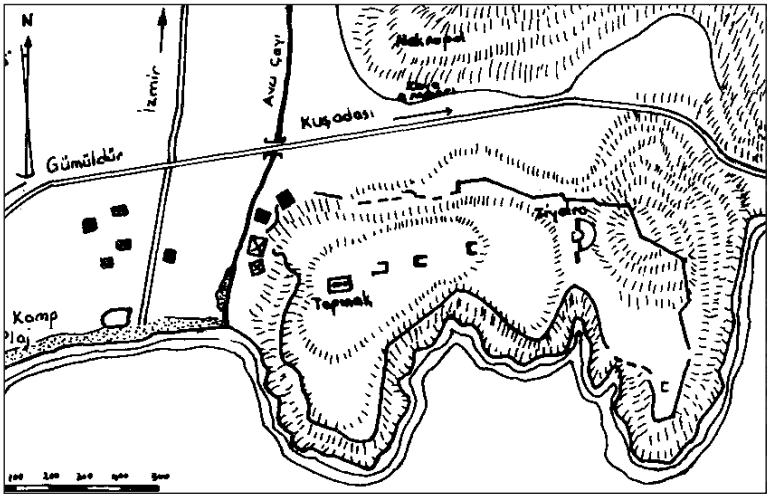


Figure 30. General plan of ancient Notion and its necropolis. Source: Atalay (1986), 77, plan 1.

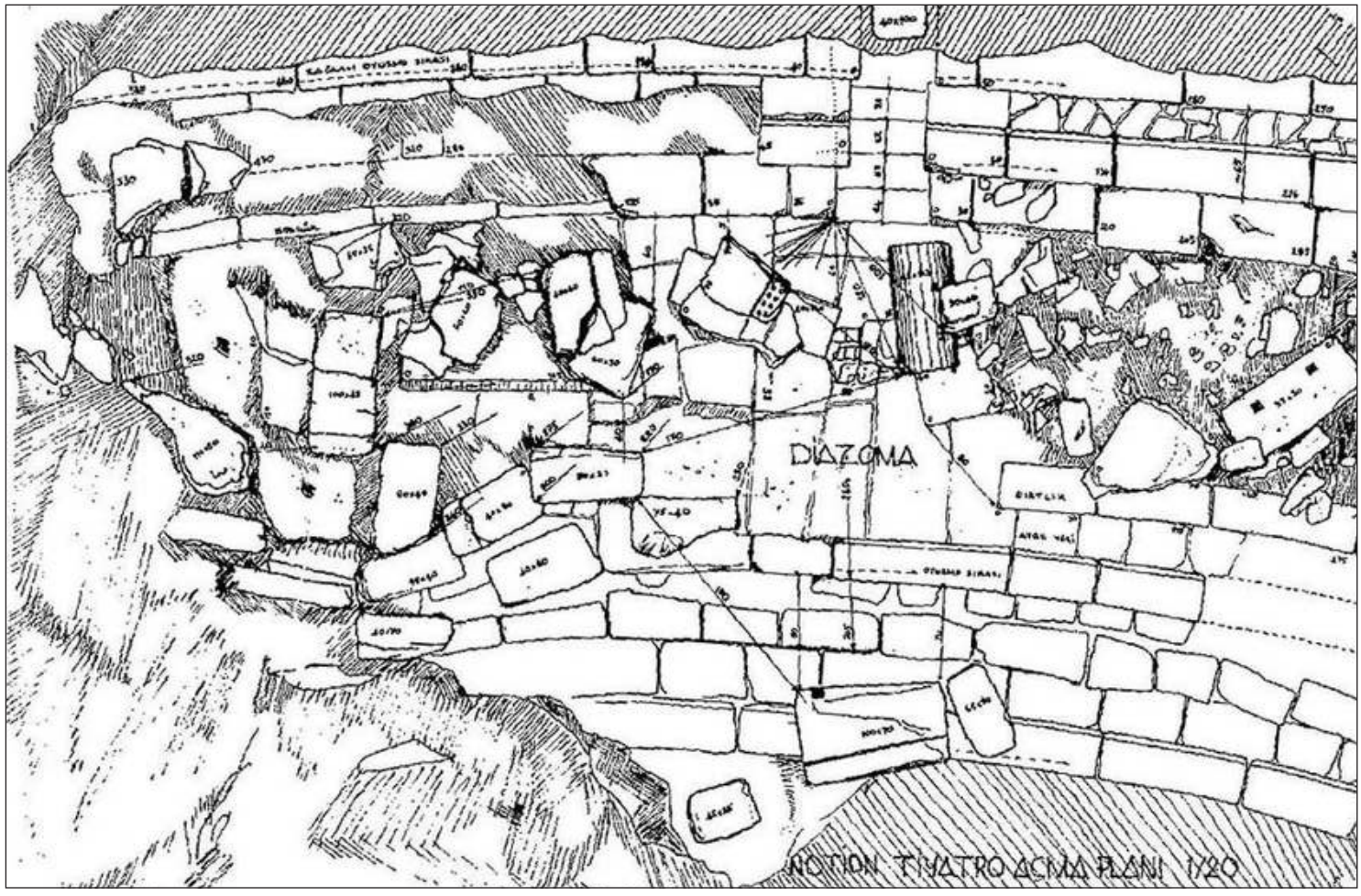


Figure 31. Trench plan (1/20 scale) of the theater at Notion, 1986. Source: Atalay (1987), 152, figure 3.

Following this vegetation cleaning intervention, Atalay began his first excavation in the theater, specifically focusing on its cavea. Furthermore, in order to document the architectural integrity of the structure, Atalay's team produced the first detailed 1:20 scaled trench plan of the excavated sections. This architectural documentation aimed to establish a layout for further investigations of the theater.

During these excavation campaigns, Atalay focused not only on the seating area and the diazoma but also investigated the skene (stage building). Remarkably, his excavations revealed later-period domestic structures built directly over the skene. He noted that these houses were constructed using the original ancient stones from the stage building. The discovery of 19th-century porcelain plate fragments within the walls proved that the theater area had been used as a settlement during the late Ottoman period.

Despite revitalizing research on the site after decades without investigation, Atalay's project ended prematurely due to his sudden death in 1988. Consequently, his excavation campaigns could neither complete the entire investigation phase of the theater nor had the opportunity to expand further into the central civic buildings of the acropolis.

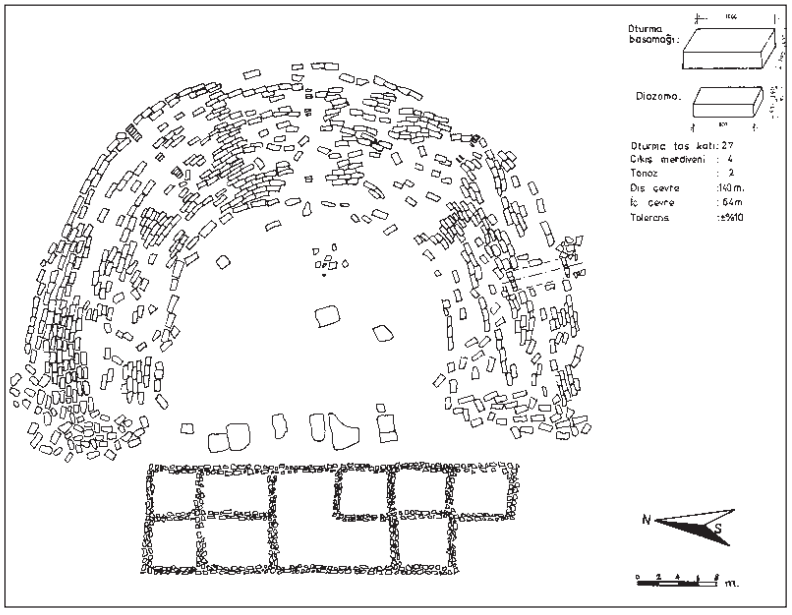


Figure 32. Plan of the theater at Notion, 1986. Source: Atalay (1987), 152, resim 3.

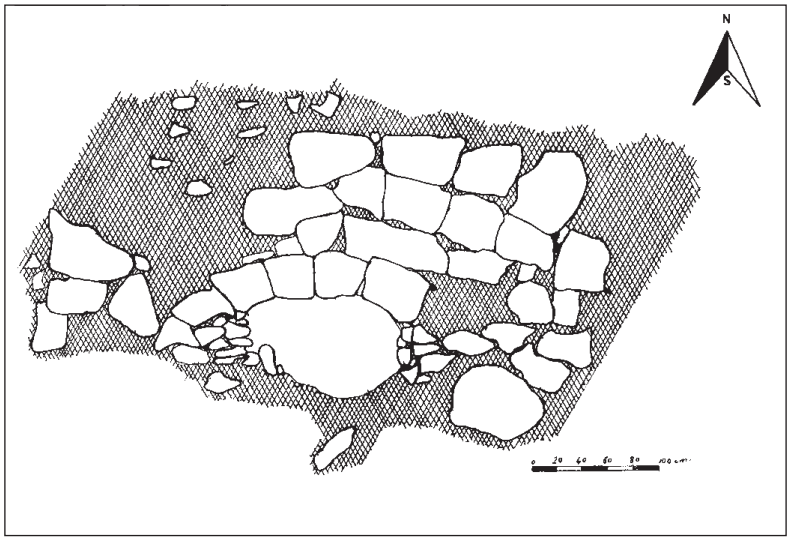


Figure 33. Diazoma back elevation, theater at Notion, 1985. Source: Atalay (1987), 80, plan 5.

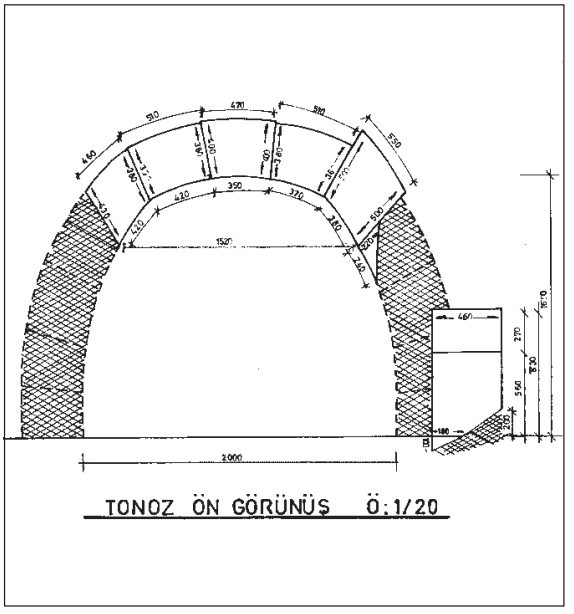


Figure 34. Diazoma front elevation, theater at Notion, 1985. Source: Atalay (1987), 81, plan 6.

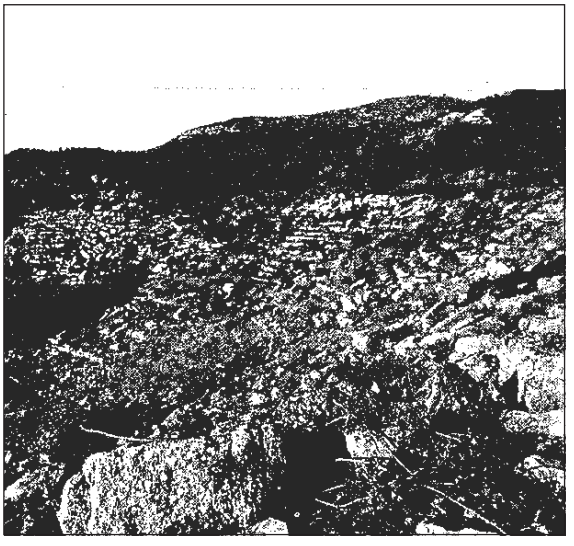


Figure 35. Cavea steps of the theater of Notion showing dislocation caused by tree roots. Source: Atalay (1986), 84, resim 4.

2.3.5 Mustafa Büyükkolancı (1994–1996)

The rescue excavations resumed in 1994 under the direction of Mustafa Buyukkolanci for the Ephesus Museum. Unlike his predecessors, Buyukkolanci focused on the central civic and religious monuments of the acropolis. In addition to the monuments of the Notion acropolis, his team carried out extensive cleaning operations along the fortification walls in order to obtain a reliable topographical city plan. These comprehensive surveys led to a remarkable topographical discovery: the city's harbor extended into the northern valley until the Late Roman period, proving that the northern fortification entrance originally served as the actual harbor gate (Fig. 36).

The team of Büyükkolancı excavated a 4 by 14 meter trench on the northern side of the council house auditorium in the Bouleuterion (Fig. 37), now designated as the MB trench. During this excavation, his team revealed significant architectural elements, including a conglomerate column drum, a marble Doric column capital from the ambulatory, several bench blocks, and a finely carved marble crowning molding of a bronze statue pedestal.

Furthermore, regarding the small temple located just west of the Agora, excavations revealed a subterranean room (also described as a *crypt*) measuring 1.70 by 1.70 meters with a depth of 1.60 meters, located in the western half of the building Measuring 9.80 by 14.93 meters, the structure was initially identified as a Heroon by Büyükkolancı due to the existence of this crypt; however, the structure is also defined as a Temple of Apollo by some scholars (Fig. 38). This alternative hypothesis is based on the crypt's similarities to the underground chamber of the oracle center at the nearby Sanctuary of Apollo at Claros. Moreover, his team recovered fragments of intricately carved architectural ornaments, such as Ionic and Lesbian cymation moldings, demonstrating the exceptionally high quality of stone carving at Notion.[51]

Additionally, investigations at the gate of the northern fortification walls also revealed a later Byzantine wall constructed directly into the earlier Hellenistic entrance. Apart from the architectural findings, the small finds had been collected and transferred to the Ephesus Museum. Büyükkolancı's excavations resulted in the recovery of 77 small finds and sculptural fragments, currently preserved in the Ephesus Museum in Selçuk.[52] Among the most notable discoveries were fragments of the colossal marble cult image of Athena. The majority of the daily-life artifacts consisted of terracotta loom weights in lentoid and pyramidal shapes, many of which were stamped, including a well-preserved stamp depicting the goddess Nike. The deposits also contained a diverse collection of lighting and cooking equipment, such as black-slipped Ephesus-type lamps, a 1st-century BCE Italian Dressel 1A lamp, Hellenistic mold-made brazier handles, unguentaria, terracotta figurines, and a bronze clam shell. Consequently, while Atalay provided remarkable insights into the necropolis and the identity of Notion's citizens through funerary stelae, the systematic work of Büyükkolancı revealed essential architectural details and a substantial assemblage of daily and sacred artifacts.

51. Mustafa Büyükkolancı, "1994 Yılı Notion Kazıları," VI. Müze Kurtarma Kazıları Semineri (Ankara: Kültür Bakanlığı, 1996), 371-381; Christopher Ratté, "Archaeological Research at Notion, 2022-23," 44. Kazı Sonuçları Toplantısı Bildirileri, Vol. 4 (Ankara: Kültür Varlıkları ve Müzeler Genel Müdürlüğü, 2024), 341-342.
52. DiFabio, "Past and Present Research at Notion"; Büyükkolancı, "1994 Yılı Notion Kazıları," 371-381.

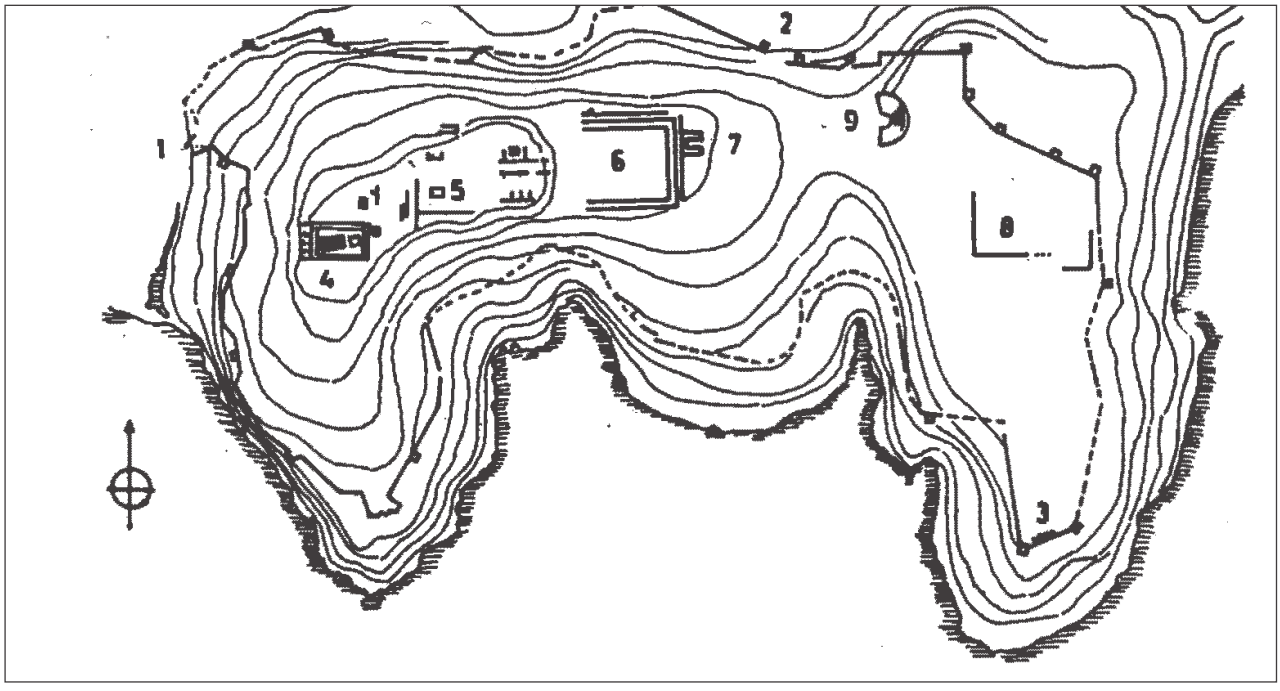


Figure 36. General city plan of Notion, illustrating the locations of the civic monuments, fortification walls, and the northern harbor gate. Source: Mustafa Büyükkolancı, "1994 Yılı Notion Kazıları," VI. Müze Kurtarma Kazıları Semineri (1996): 375, plan 1.

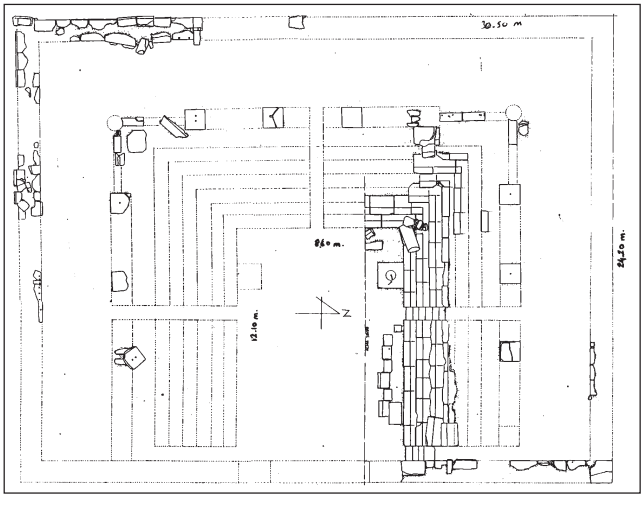


Figure 37. Plan of the excavated bouleuterion and recovered architectural elements. Source: Büyükkolancı (1996), 378, plan 3.



Figure 38. Subterranean room (crypt) in the cella of the Heroon at Notion. Source: Büyükkolancı (1996), 381, resim 6.

2.3.6 Christopher Ratté (2014 - Present)

The last investigation and excavation campaign throughout the Notion ancient city's history, directed by Christopher Ratté from the University of Michigan, has been conducted in two phases. The primary phase of the investigation operated between 2014 and 2018, the research team conducted a comprehensive, non-invasive survey designed to map the city and trace its urban evolution. During this preliminary phase, advanced techniques such as advanced aerial photogrammetry with drones and tethered blimps to create detailed 3D terrain models. However, the goal of this phase was to map the urban layout and its evolution throughout history without making major physical interventions to the city's terrain. In conjunction with these aerial surveys, comprehensive geophysical prospection, like magnetic gradiometry and ground-penetrating radar (GPR) was utilised in order to detect the subterranean street grids and massive buried structures; such as the gymnasium of the ancient city. Moreover, thermal imaging using the heat dissipation had been used for defining the locations of the covered foundations. While conducting these remote sensing techniques, the team executed a systematic surface collection program by 30 to 30 meters grid layouts, across the site (Fig. 39). The diagnostic pottery recovered during this collection was remarkably pointed out that the most occupied phase of the city throughout its history lasted for a short period and spanned primarily from 3rd century BCE to the 1st century CE. [53] Besides the survey also documented the locations of both the eastern and western necropoleis of the ancient city (Fig. 40).

Subsequently, a secondary excavation phase was initiated by utilizing the collected data from the first phase of the program in order to systematically investigate the structures of the ancient city. These ongoing excavations are strategically aimed at both civic monuments and residential structures. During the investigations in the Bouleuterion (Council House), the auditorium and the orchestra were cleared. Notably, in the 2024 campaign, archaeologists unearthed an in-situ marble statue base dedicated to Emperor Augustus in the center of the orchestra (Fig. 41). The monument bears the rare epithet "Bringer of Reconciliation" (Illastherios). Within the residential areas of the city, the excavations had concentrated on a large Hellenistic peristyle house situated on the west ridge of Agora. During the excavation, another Classical period layer was discovered beneath the floors of this Hellenistic structure. In July 2023, the excavators made a spectacular discovery, a hoard of 68 gold Persian coins (darics) dating back to the 5th century BCE, found buried in a small ceramic pot. Remarkably, these findings featured characteristics of "kneeling archer" design, and probably these coins had been used as payment for mercenary troops during the Peloponnesian War.

Furthermore, second excavations started in 2024 in East Ridge House, aimed at understanding the urban planning variations between eastern and western neighbourhoods of the city. Beyond the urban core, another excavation was conducted nearby Ahmetbeyli Beach. This site was investigated initially for building up an excavation house, however exploratory trenches revealed unexpected findings. Especially, the team revealed the foundations of a Late Roman Warehouse dates back to 5th and 6th century CE. The abundance of vessels primarily used for Ephesian wine, which is recalled as "Late Roman Amphorae" (LRA 3) recovered here; thereby this finding refers that Notion's harbour continued to function as an vital commercial shipping hub centuries after the acropolis had been significantly abandoned. Additionally Ratté also documented a substantial aqueduct featuring an inverted siphon and a venter bridge, which was functioning to carry fresh water across the Hales River valley into the water source-scarce city Notion.

Ultimately, Ratté's comprehensive approach with his team extended far beyond an academic investigation, and the project involves constructing partial security fences in the northern part of the site. [54]

53. Matthew Naglak and Gregory Tucker, "Mapping Notion: Non-Invasive Survey Using Aerial Photogrammetry, Personal Autopsy, Thermal Sensing, and Geophysical Prospection," AIA Annual Meeting (2016.
54. Christopher Ratté, "Fieldwork at Notion in 2023, Final Report," Notion Archaeological Project (2023), 21.



Figure 39. Restored city plan of Notion. Source: Ratté (2025), fig. 1.

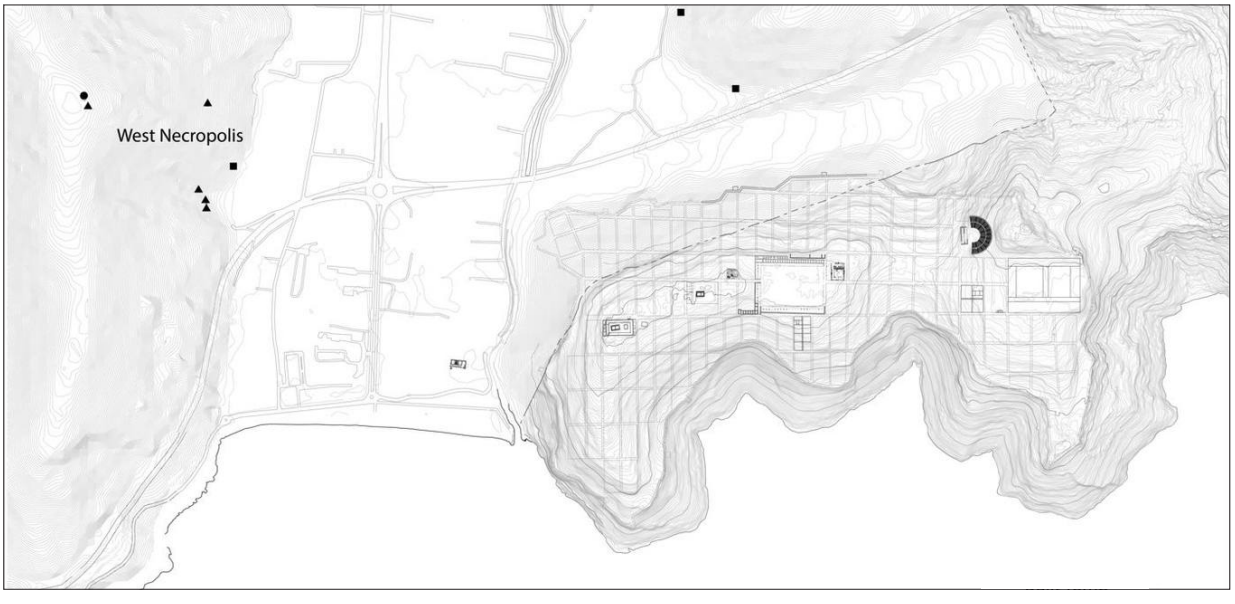


Figure 40. Map showing locations of cemeteries of Notion. Source: Ratté (2025), fig. 28.

The comprehensive surveys and systematic excavations were initiated in 2022. This ongoing campaign targets both civic monuments and residential areas to investigate the hypotheses generated during the survey. Bouleuterion excavations in the orchestra revealed an *in situ* marble statue base, dedicated to Emperor Augustus, which has the inscription saying " Bringer of Reconciliation" (Ilastherios). (Fig. 41) It likely reflects the ideological reflection of the community at the end of the Roman civil wars. The Augustan refurbishment of the orcheastra was likely also included the displacement of the central pedestal situated just south of the statue. Nevertheless, the Augustan period was short-lived for Notion due to the clear understanding that Notion was abandoned short after this period.

Beside of the statue base, the team also documented the fallen architectural blocks as Doric piers and a triglyp frieze, that originally from the single story Doric stage building upon the eastern podium (Fig. 42). The stratigraphic evidence and the lack later-period materials in the Bouleuterion despite the Augustan refurbishment, demonstrates that Bouleuterion was abandoned during the first century CE. The earlier historical layers revealed a hoard of Persian coins which is called darics, illustrating the kneeling archer design by providing rare material evidence of the city's geopolitical turbulence during the Peloponnesian War (Fig. 43). Moreover, the exploratory trenches near the modern beach uncovered a Late Roman warehouse dates back to 5th-6th century CE, has revelaed the LRA 3 transport amphorae. This discovery fundamentally reshapes the historical narrative of Notion, proving that even though the upper city may have been largely abandoned in the early imperial era, the port continued to function as an essential commercial and maritime center for centuries. The distribution of these findings across the two promontories and the coastal zone reflects the diverse functional zones that characterised the city's urban layout.



Figure 41. Statue base in the Bouleuterion featuring the Greek inscription. Photo by the author.



Figure 42. Fallen architectural blocks and piers in front of the eastern podium of the Bouleuterion. Photo by the author.



Figure 43. A 5th-century BCE Persian gold coin (daric) featuring the "kneeling archer" design, discovered within a hoard beneath the Hellenistic peristyle house at Notion. Source: Ratté, C. (2023). Fieldwork at Notion in 2023, Final Report. Notion Archaeological Project, University of Michigan.

03.

URBAN AND ARCHITECTURAL DEVELOPMENT OF NOTION

3.1 Landscape and Topography

3.1.1 Topography



Figure 44. General topographical view of the site. Photo by author.

The Notion ancient city encompasses an area of roughly 35 hectares and occupies a highly strategic position overlooking the Aegean Sea. Specifically, the city is located on the central ridge (Fig. 44) that extends east to west, parallel to the coastline, and it is distinctly framed by two prominent promontories that are projecting southward. Furthermore, the western boundary of the site was naturally defined by the Hales River, also recalled modern Avcı Çayı. The city terrain is characterized by steep northern and southern slopes, which naturally define the topographical borders. In order to overcome this uneven topography, the central ridge was extensively modified in antiquity; broad level terraces were carved from the native rock to create usable flat spaces.

Additionally, the peak point of the entire topography is situated on the east of the ancient theater, elevated around 85 meters above the sea level. Defining physical characteristic of the landscape is its isolation and lack of modern development. As the city has not been occupied by the modern buildings, the terrain represents an exceptional "surface legibility". Consequently, the natural contours of the hills and the steep slopes create a demanding terrain, within which the traces of the ancient urban layout have survived in an inseparable integration with the landscape (Fig. 45).

3D Axonometry of the Site

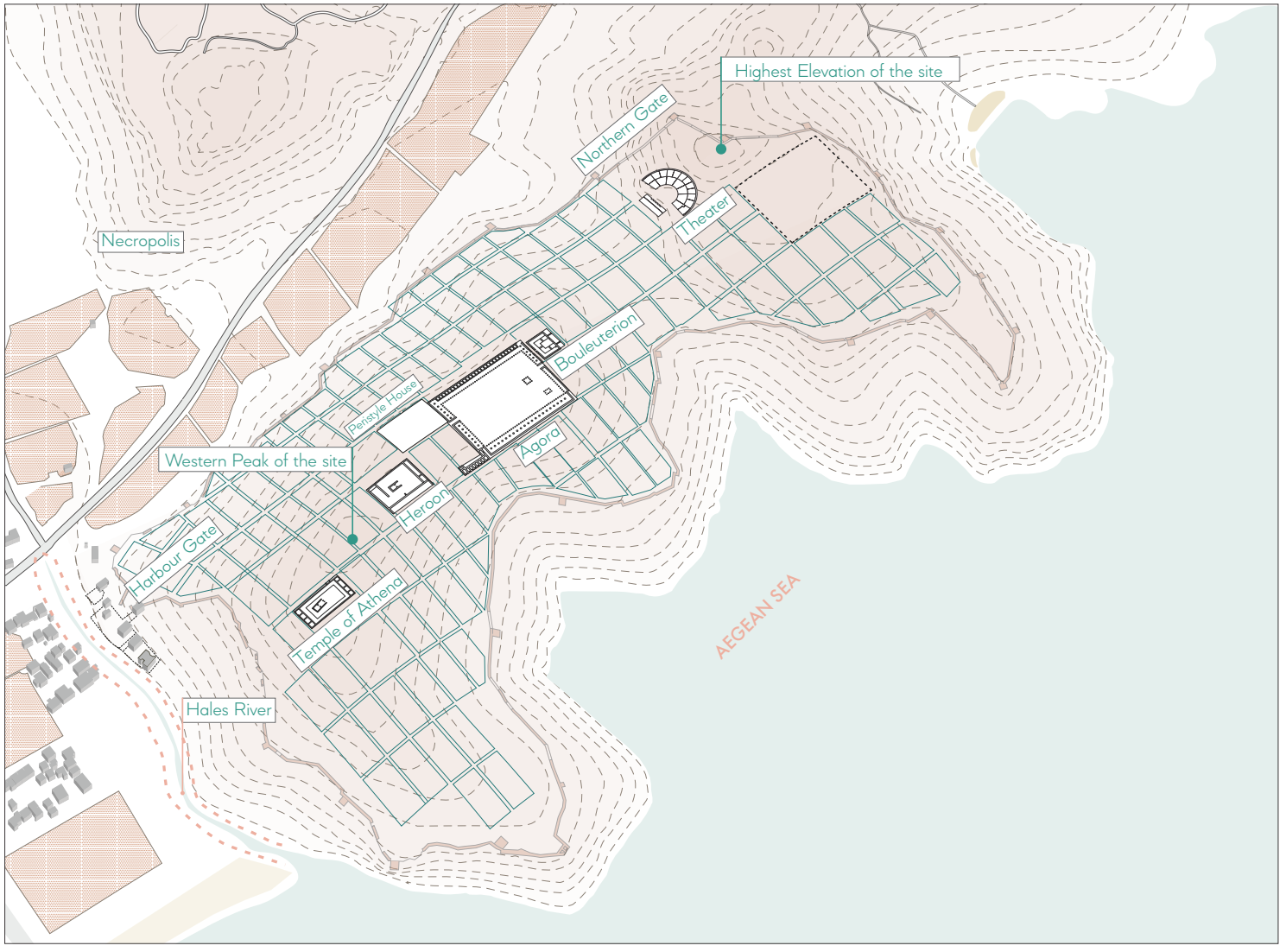


Figure 45. 3D view of Notion illustrating the isohips contours and the site. Drawn by author.

3.1.2 Local Geology and Quarrying

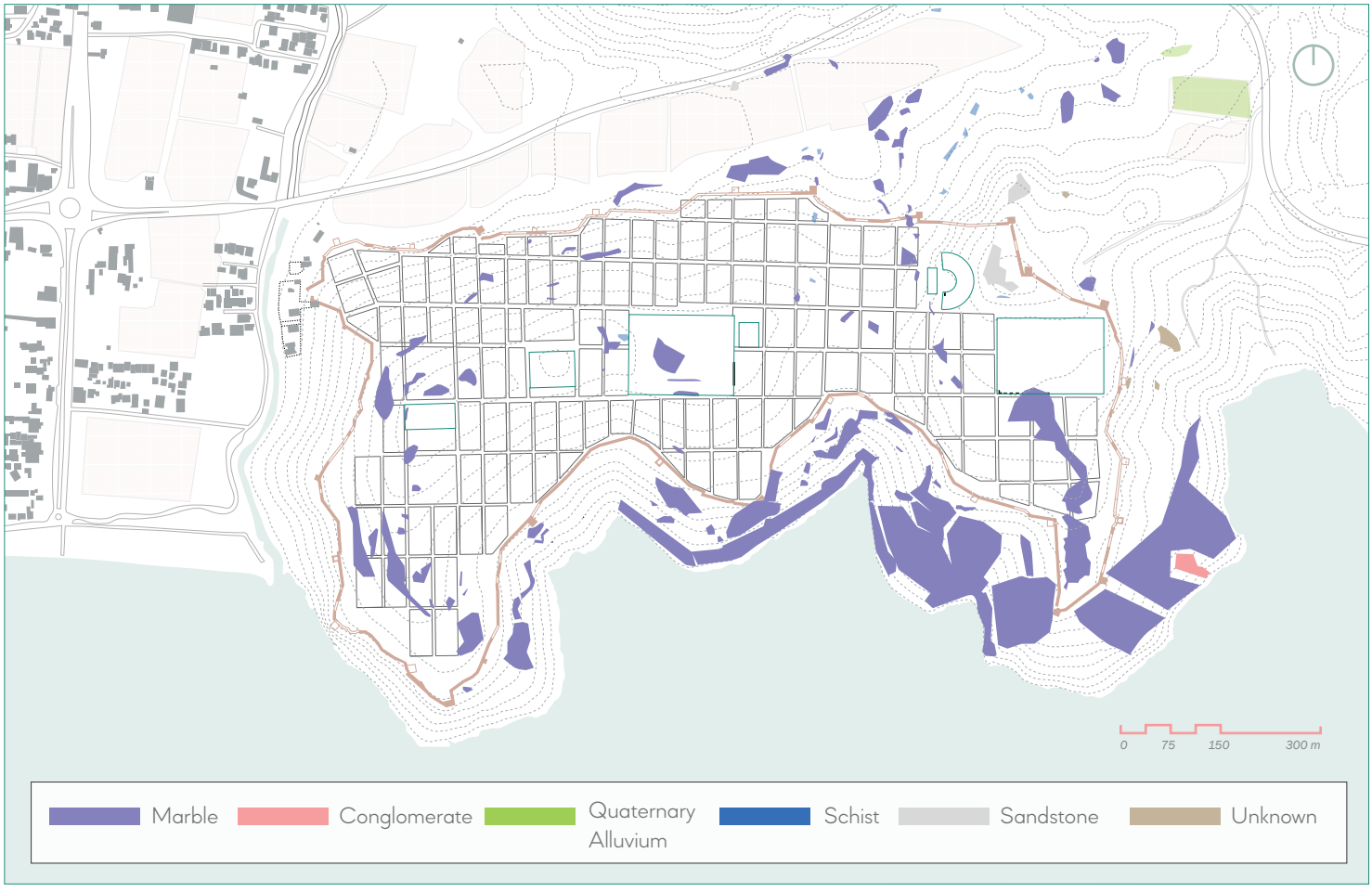


Figure 46. Geological outcropping map of Notion. Adapted from Ratté, Commito, and Knoop (2018), 291–302.

The bedrock of Notion is primarily characterised by a complex geological stratigraphy. However, the geological investigations have revealed a distinctive sequence of the rock units across the site. During the investigations, the lowest exposed layer consists of grayish-white marble, frequently interbedded with the grayish-whitish schist (Fig 46). Above these basalt layers, the stratigraphy continues with the calcareous sandstone capped by the layer of conglomerate rock, which is locally covered by Quaternary alluvium and colluvium. These geological formations have undergone intense tectonic activity, resulting in faults and folds that shaped the topography of the city. The marble unit exhibits prominent south-north trending folds, including both antiforms and synforms, as well as small scale silica beds that show sharp S and Z folds. Moreover, major fault lines defined the boundaries of the promontories. Most notably, a significant east-west trending fault defined the shoreline of the small inlet west of the eastern promontory; this fault also forms a small canyon at the top of the promontory due to the rapid weathering of deformed and brecciated marble. Similarly, another major fault naturally defines the steep coastline of the western promontory.



Figure 47. View of quarry on west promontory, looking north. Source: Ratté, Rojas, and Commito (2017), photo 9.

The monumental and civic architecture of Notion was heavily dependent on the extraction of these geological resources. The construction of the city required the extraction of approximately 100,000 cubic meters of local marble that resulted in the creation of the broad, artificially leveled terraces where the sanctuaries and the Agora are now located.[55] Interestingly, while the conglomerate stone was the primary material for the civic structures of the city such as the theater and council house; however geological surveys indicate that revealed conglomerate stones are really less in the site. This scarcity could be considered as the conglomerate used in constructions had transported from off-site quarries, likely situated to the northeast beyond coastal highway (Fig.47). In contrast, the local schist was systematically quarried on-site in order to provide flat paving slabs used extensively for paving of the city.

55. Ratté, Rojas, and Commito, "Notion Archaeological Survey 2017-2018," 6; Ratté, Commito, and Knoop, "Notion Archaeological Survey, 2016," 301.

3.1.3 Hydrology and Coastal Evolution

Notion's coastal evolution throughout the history and its hydrological structure are among the primary factors that affect the architectural and geographical development of the city.However, it must be noted that the city did not have natural fresh water sources (springs) on its promontories. In order to overwhelm this fresh water scarcity in the city, the rock-cut cisterns and aqueduct spanning the Hales River valley. Furthermore, the coastal line of the site had been shaped due to the alluvium that carried by the Hales River (Fig. 48). Correspondingly, the main reason the Archaic and Classical period settlement is not visible today, is that the initial settlement was buried under a thick layer of alluvial silt accumulated by the river. The most notable evidence of this coastal evolution is the location of the Late Roman Warehouse near the Ahmetbeyli Beach at the southern part of the city, which was revealed with the excavations. Specifically, this discovery of the warehouse found 0.25-0.30 meters below the current ground surface, which is surprisingly close to the current modern coastline. Consequently, this discovery had refuted the thesis proposal in the earlier research that the ancient coastline had been located much further inland. Thereby, the hypothesis about the coastline during the Late Antiquity had to be reassessed. [56] Besides, the archaeological trenches conducted in this harbour part revealed that the city utilised the advanced engineering approach related to hydrological risk management and the flood risk control. During the Late Roman period, an earthen embankment was constructed in order to prevent destructive floods of Hales River. However, the embankment had aligned with the eastern line of the warehouse and it expanded southwardly for around 60 meters. However, the effectiveness of the embankment is proved by the recent stratigraphic analysis, while the river facing part of the embankment is observed traces of the flood; on the other hand no flood traces on the western side due to the embankment protection.

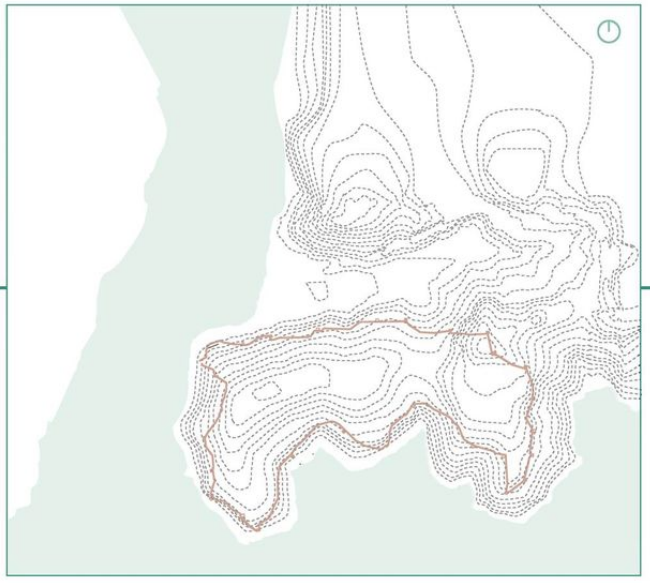
In conclusion, the coastline of Notion and the hydrological structure did not only cause the early settlements to stay buried under the alluvium but also created a necessity for the construction of embankments to take precautions against the flooding risk during Late Antiquity, while harbor activities were ongoing.[57]

56. Angela Commito, "The Cisterns of Notion," AIA Annual Meeting (2016).
57. Ratté, "Fieldwork at Notion in 2024, Final Report," 17-18.

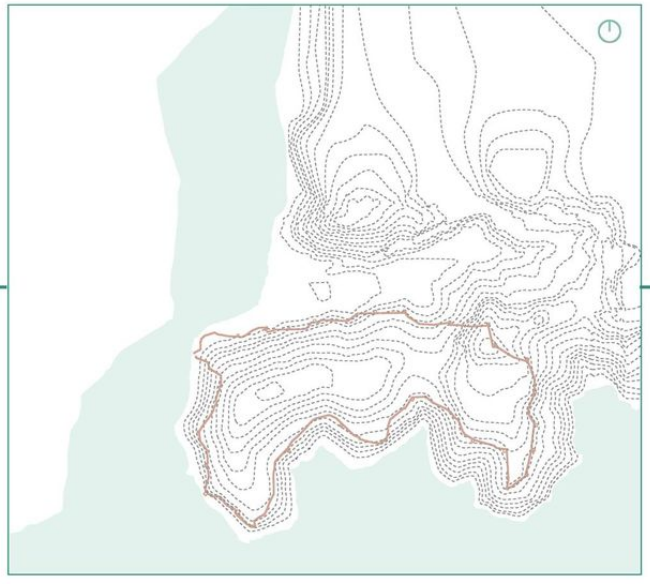
6th century BCE Coastal State of the Topography



Year-0 Coastal State of the Topography



6th Century AC Coastal State of the Topography



Present Coastal State of the Topography



Figure 48. Diagram of the coastal evolution of the Notion promontory. Created by the author based on Doğan (2009).

3.2 Urbanistic Development and Changes over Time

3.2.1 Archaic and Classical Period (6th - 4th Century BCE)

Even the ancient written sources state that Notion's origin dates back to the 6th century BCE, archaeological evidence shows that the early city was not located on the high hill (acropolis). Instead, the settlement was near the harbour and the Hales River, at a lower level. Currently, this original settlement can't be seen due to the layers of river mud (alluvium).[58]

The settlement expanded through the Acropolis by the 5th century. However, through the recent archaeological investigations, the foundations of the Classical houses had been discovered beneath the later West Ridge House, and the Athenian pottery was found in the eastern neighborhoods, proving that this early settlement spanned both sides of the hill. However, most remarkable urban feature of this period is how the urban layout shaped the Notion City's layout. During the Peloponnesian War (430–427 BCE), the city had been divided into two between the supporters of Athens and the supporters of Persia. The partition wall (diateichisma) was built through the middle of the city in order to separate two opposing groups of populations. It must be mentioned that this was a particular example of the civil conflict literally dividing an urban space in half. It is crucial to examine the physical, urban and political division of Notion, because it provides a better understanding for the Hellenistic grid plan of the subsequent phase.[59]

3.2.2 The Hellenistic Re-founding (3rd – 1st Century BCE)

In the early 3rd century BCE, the Hellenistic period marked a transformation phase in the urban layout, which was replaced by the scattered layout of the earlier city. During the refounding (synoikismos) process, the old, irregular settlements were abandoned. Instead, the city was redesigned on the 35-hectare rocky promontories using a rectilinear grid plan named as "Hippodamian system". In order to implement this grid plan on the steep and rough landscape, the central ridge of the terrain was levelled to generate the broad and flat terraces, establishing a central civic axis where the public buildings were concentrated. Unlike the inner-city division wall constructed in the Classical period; the Hellenistic layout of the city was secured with an outer 3 km long fortification wall.

The new city plan featured a deliberate system of social zoning. On the western side, the street blocks were designed in a 1:2 ratio, which creates the standard house plots around 218 square meters, which is 50 x 50 Ionic feet. Likewise, on the eastern side, the streets were arranged much wider house plots nearly twice as large (approximately 435 square meters). This obvious difference highlights a strict social distinction; the wealthy elites likely settled to the larger plots near to Gymnasium in the east, while the merchants and craftsmen lived in more dense plots near to the Agora and harbor in the west.

58. İlhan Kayan, "Klaros Kazı Alanında Jeomorfolojik-Jeoarkeolojik Araştırmalar," Ege Coğrafya Dergisi 8 (1995): 2.
59. Schuchhardt, "Kolophon, Notion und Klaros," 420.

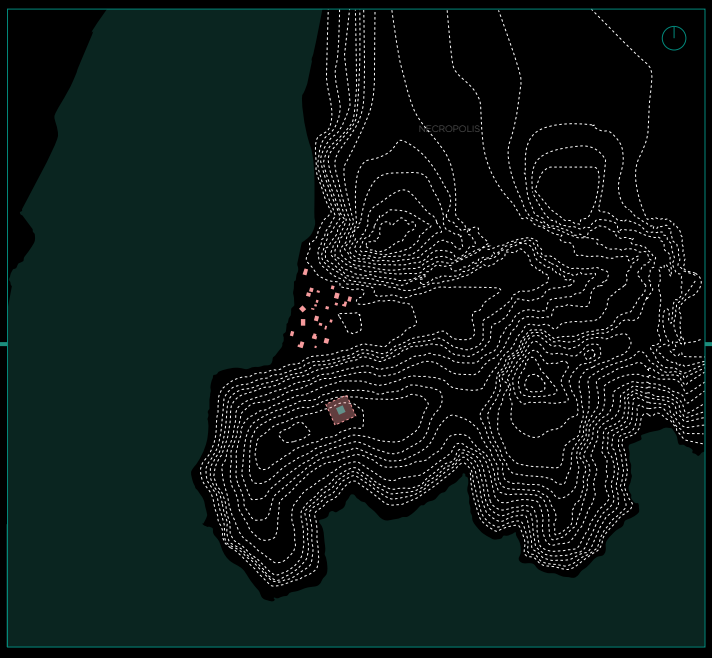
3.2.3 The Roman and Late Antique Period (1st – 6th Century)

The city experienced a rapid population decline during the Early Roman Period. This decline resulted due to the significant expansion of the neighboring city Ephesus, which, supported by the Roman Empire, attracted people and resources away from Notion. The grid planned settlements were largely abandoned by the 1st century CE. Nevertheless, this population shift did not signify the complete abandonment of the city yet; instead the center of settlements moved from hilltops to the coastline and the areas beyond the city walls. The recent discovery of a Late Roman warehouse complex near to Ahmetbeyli Beach, dating back to 5th and 6th centuries, indicates that the harbor and the trade system continued to operate after the promontories of the city were abandoned (Fig. 49).

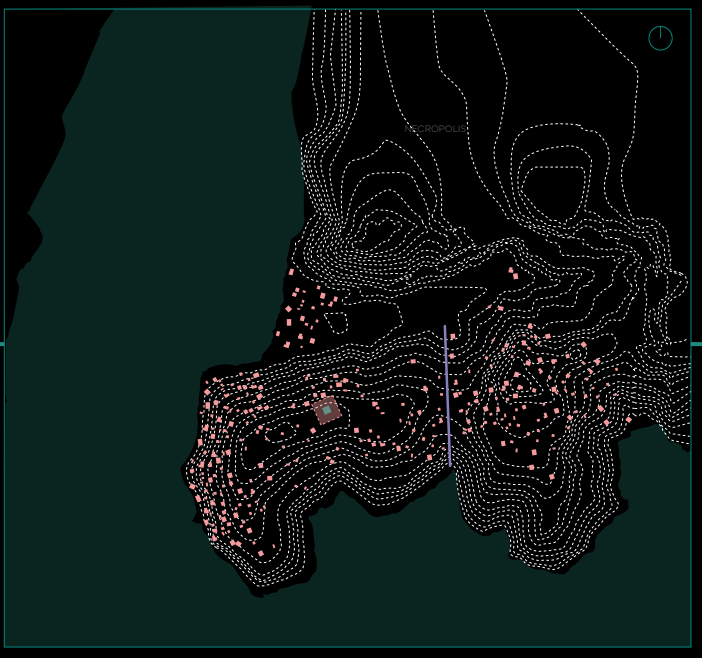
Finally, the discovery of the small apsidal buildings within the ruined Hellenistic grid, together with a large bishop's basilica located 500 meters north of the city walls, highlights that the settlements and placement of the new structures did not follow the urban grid-layout anymore. During the Late Antique and Byzantine periods, Notion did not function as a centralized, and walled city; instead it became a decentralized, scattered settlement where maritime, religious and rural activities distributed across the ancient landscape. [60]

60. For the 11th-century epigraphic evidence and the initial discovery of the extramural basilica, see Macridy, "Altertümer von Notion," 155-173.

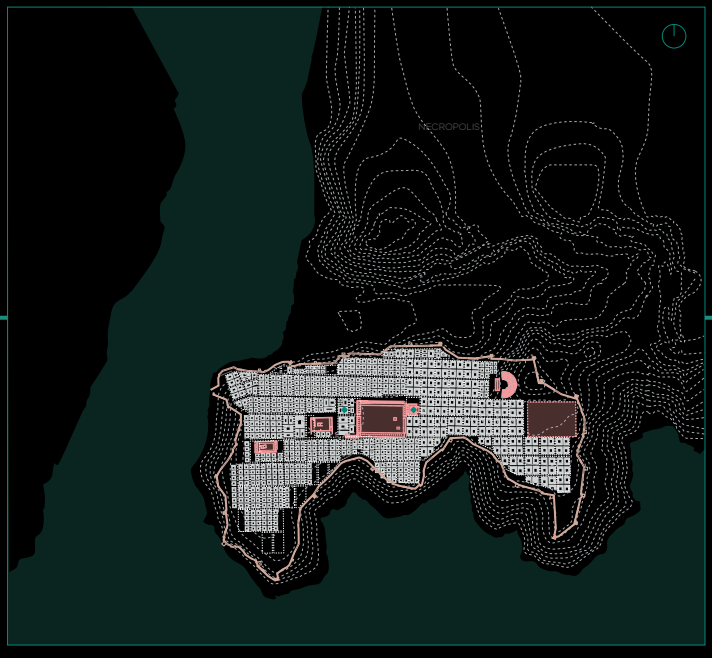
Urbanistic Development through the Centuries



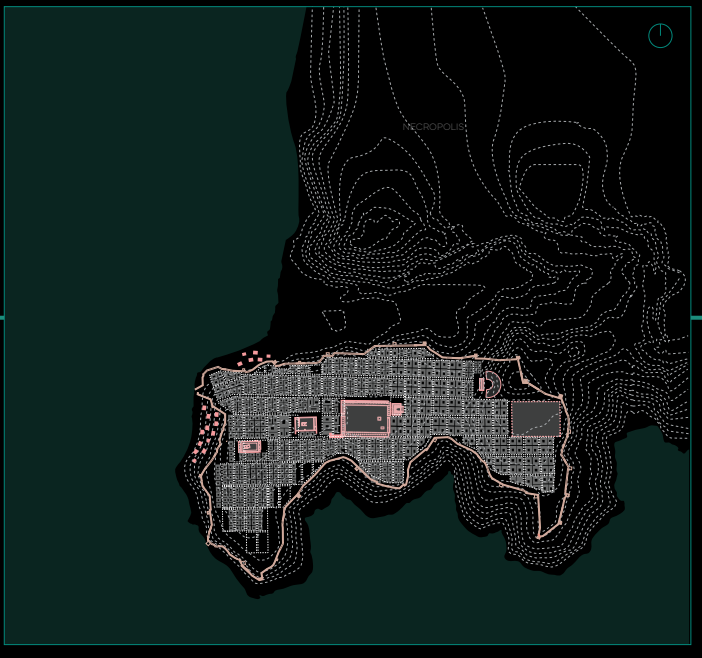
6th Century BCE



5th Century BCE



1st Century BCE



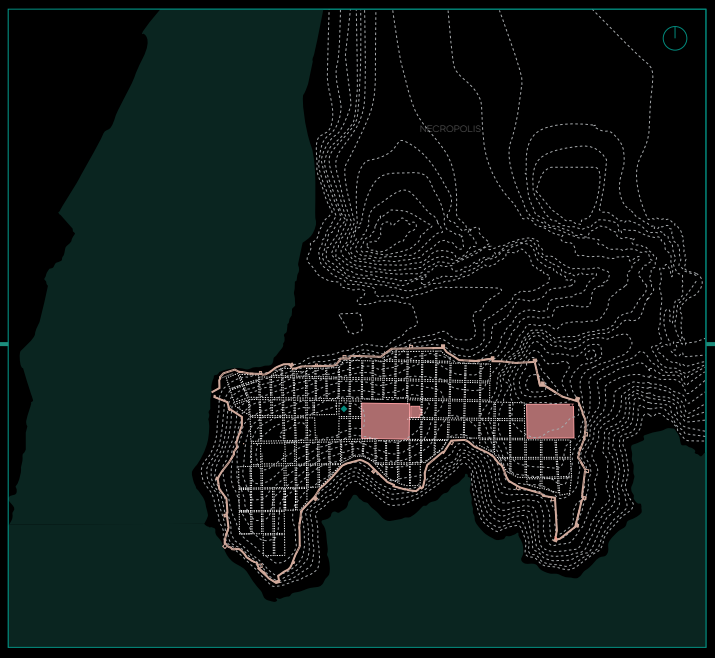
5th Century AC

Residential settlements

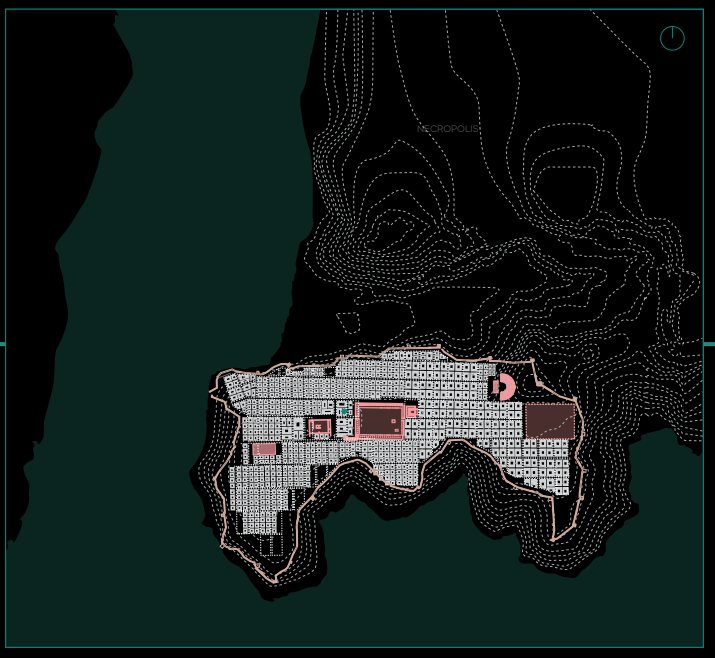
Additions-renovation

Earlier phase of the building

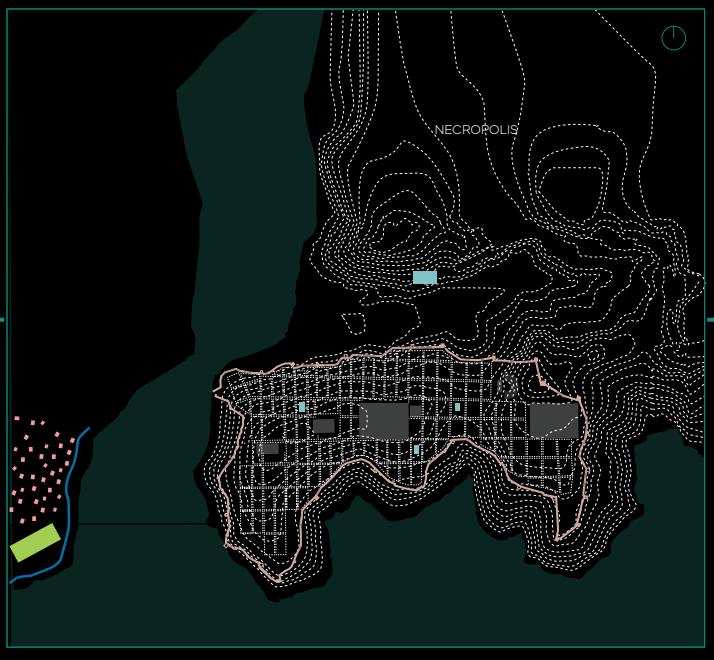
Existing building



3rd Century BCE



2nd Century BCE



6th Century AC



Present

Late Roman Warehouse

Embankment wall

Episcopal Basilica and Church

Diatechisma(separation wall)

Figure 49. Urbanistic Evolution of Notion through the centuries. Diagram by author.

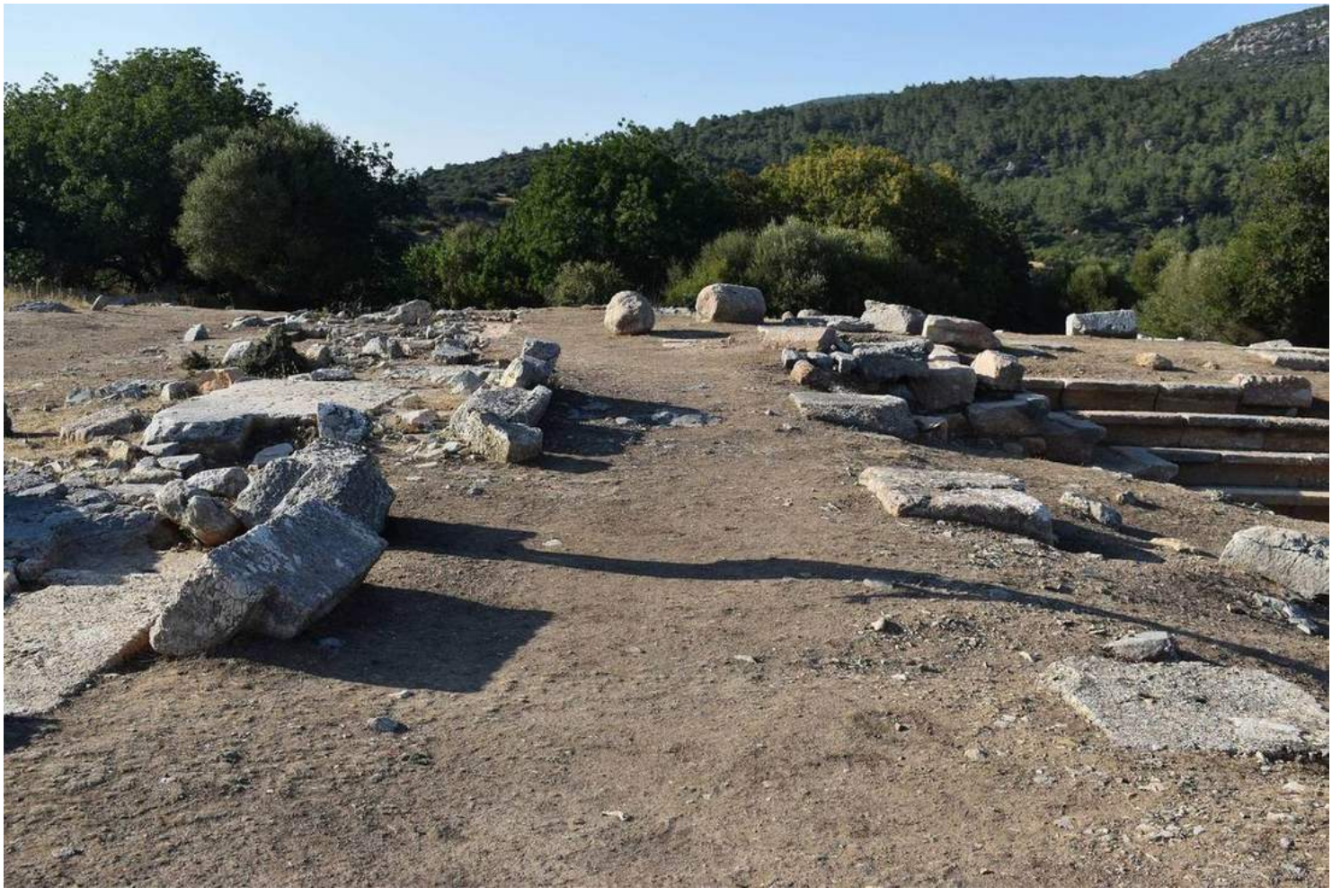


Figure 50. Street view between the Agora and the Bouleuterion. Photo by the author.

3.3 Urban Infrastructure and Planning

The urban infrastructure and planning of Notion were fundamentally shaped by the "refounding" (synoikismos) in the Hellenistic Period. Since it was highlighted in the previous section on city's urban evolution, the urban regulation had replaced the scattered settlement patterns of Archaic and Classical periods. This urban project required a massive mobilization of labor and resources to transform the steep natural landscape into a highly organized civic space. The resulting master plan was a testament to Hellenistic urban ideals, seamlessly integrating domestic life, public administration, and defense. The city was rebuilt across two promontories covering approximately 35 hectares with an orthogonal street grid system, water management systems, fortification walls and mural cemeteries (Fig. 50)

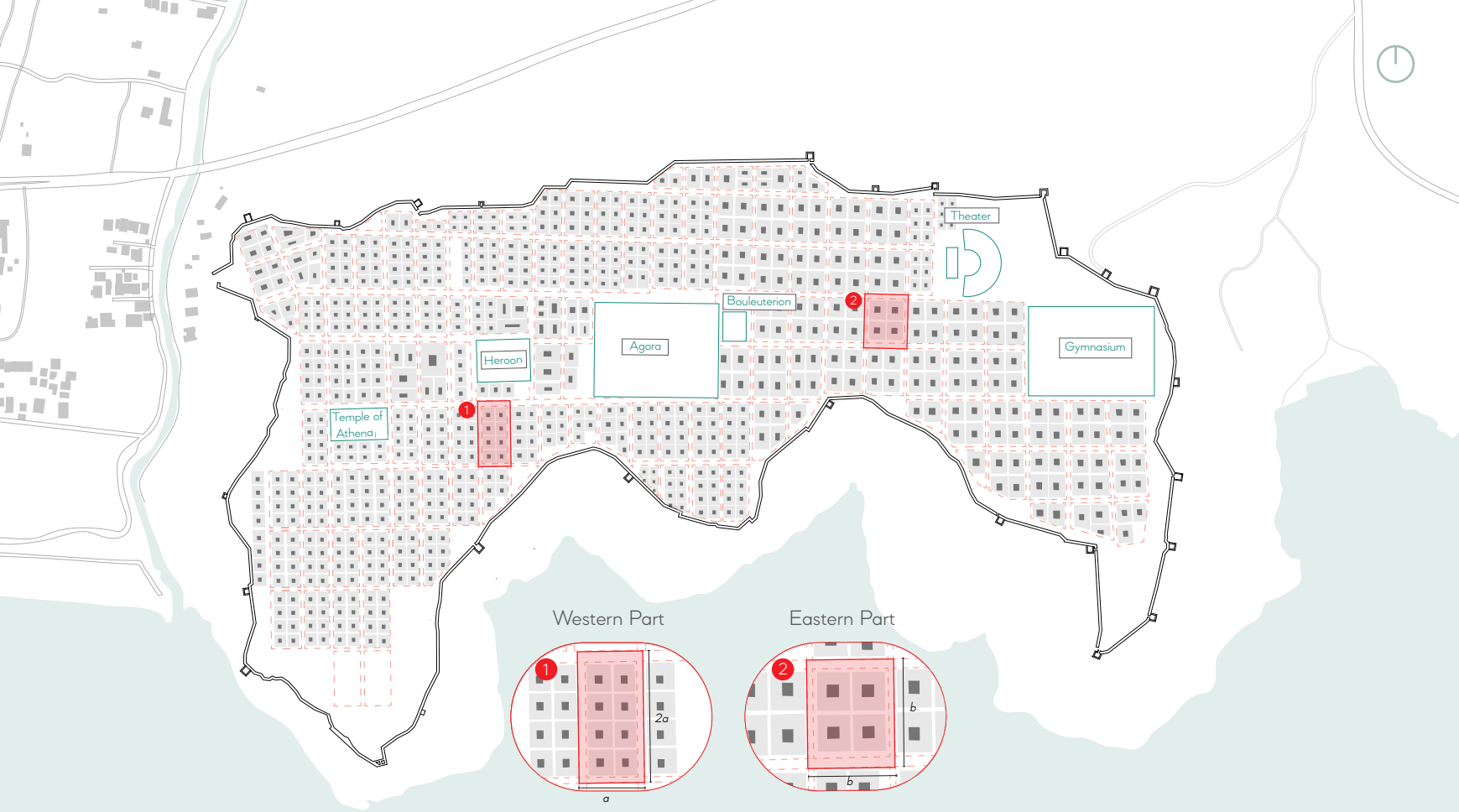


Figure 51. Schematic plan showing the urban grid layout of Notion. Based on the topographical survey by Ratté, Rojas, and Commito (2017).

3.3.1 Grid Planning System

Notion had an orthogonal grid plan (Hippodamian system), which is a characteristic often associated with Hellenistic urban planning. The city was designed with two different planning styles that adapted to the natural landscape and social classes. In the western part of the city, the east-west streets are about 64 meters apart, while north-south streets span about 33 meters. This creates rectangular housing blocks with a 1:2 ratio (Fig. 51). In contrast, the eastern half of the city had wider streets and nearly square blocks with 1:1 ratio. The difference on the street layouts reflect a deliberate strategy of social zoning. The merchants and crafts likely occupied the smaller plots around 218 square meters on the west side of the city. Conversely, the elite resided in larger plots of about 435 square meters on the eastern part of the city. Implementing this grid plan on steep and rocky terrain, required significant engineering efforts. However, the central hills are flattened and carved into the solid bedrock to create broad, levelled terraces. The housing blocks were constructed to prevent sliding down the hill.

Excavations demonstrate that the main street passing south of the Western Ridge House is 5.9 meters wide and paved with stone. These streets functioned not only for walking, they also served as utility corridors which contained covered drainage and sewage channels running right under or alongside them, which delineated the city blocks. [61]

61. Ratté, 'Fieldwork at Notion in 2023, Final Report,' 6.

3.3.2 Water Supply System

The steep and rough topography of the city also brought natural disadvantages such as absence of fresh natural water springs. In order to address this challenge, the water management system had been designed in both territorial and architectural scales.
At the territorial scale, a large aqueduct system was constructed to transport fresh water from the northwestern hills over approximately 2 km (Fig. 52). In order to cross the deep Hales River valley, it was required to utilize inverted siphon, supported at its western end by a 50 meter long stone arcade. The pipeline itself utilized double-line clay pipes in the northern sections and single line pipes further south.

Within the city, the water supplied an urban distribution network. The aqueduct fed directly into a system of subterranean pipes that delivered water to the monumental public foundation in key civic spaces of the city, including Agora and the Temple of Athena; this indicates that aqueduct water was provided by pipes and prioritized for public use and display (Fig 53). Meanwhile, individual households utilized the decentralized rainwater harvesting system for their daily water needs. Numerous private cisterns had been constructed by carving directly into the bedrock beneath the homes, collecting the runoff water from the roofs to create a secondary water reserve with around 30 to 50 cubic meters. It is confirmed that 14 confirmed and 5 possible cisterns are existing on the site (Fig. 54). These cisterns represents a typical Hellenistic "bottle " or "carafe" shape, and expanding from a narrow opening 1-2 meters at the surface to a width 3-4 meters at the bottom, with between 5 and 7 meters. Their waterproofing of cisterns were provided by the solutions of local geological material. The cisterns in permeable schist were lined with hydraulic plaster, while the limestone cisterns did not require the additional coating.

Over time, this infrastructure became insufficient for the evolving needs of the city. The thick layers of lime or sinter gradually accumulated inside the terracotta pipes of the aqueduct. By the Late Roman period, the system had become highly inefficient. Notably the absence of large Roman bath complexes in Notion suggests that the aqueduct was never sufficient to supply the substantial water volumes required for Roman bathing culture. As a result, increasing water scarcity and the declining capacity of the aqueduct are considered primary factors contributing to the gradual abandonment of the hilltop city during the Roman and Late Antique periods.



Figure 52. View of the aqueduct channel cut into the native rock on the hill northwest of Notion. Source: Ratté (2024).



Figure 53. Terracotta single pipe belonging to the water distribution system of Notion. Photo by the author.



Figure 54. Urbanistic diagram of Notion. Diagram by author, based on Ratté, Rojas and Commito (2017); Commito (2016); and Ratté (2025).

3.3.3 The Fortification Walls

The fortification walls enclose an area approximately 35 hectares, extending for 3 km to protect the city from both land and sea. The fortification walls were constructed with thickness of 2.5 meters and preserved to heights exceeding 4 meters; the walls followed a "saw tooth" trace. This design, which had resemblances with Colophon and Priene, was strategically intended to expose approaching enemies to flanking fire. The fortification walls comprise 16 confirmed and 29 possible rectangular towers (Fig. 55), none of which were designed to accommodate heavy artillery. Gates, primarily located on the northern side, were arranged to enforce tangential rather than axial access. Furthermore, the alignment of the walls was adapted to the local topography; the northwest salient secured the harbor at the Hales River mouth, while the inclusion of the high ground northeast of the theater provided control over the road to Ephesus. The archaeological investigations indicated that the fortifications underwent at least three distinct construction and repair phases. The original Late Classical or early Hellenistic phase was built using the dry-stone technique with quarried, trapezoidal limestone ashlar blocks, featuring finely drafted corners on the towers (Fig. 56). The following phase of major repairs, particularly evident on the steep western side, dates back to the Roman Phase. These repairs utilized rough limestone, local conglomerate bedrock, and spoliated marble architectural elements, all bound by a hard coarse mortar containing ceramic inclusions (Fig. 57). Finally, a post-classical or Late Antique intervention is apparent in the northeast corner of the circuit, where the original ashlar blocks were dismantled and reused to construct terraces or cross walls between two towers.[62] The fortification wall construction required around 55.000 m3 of stone, utilizing a combination of white and blue-gray limestone, marble, schist, and a highly erodible conglomerate that constituted 20% to 30% of the walls (Fig. 58). While local quarries on the southern edges of the promontories were heavily used, a 70% waste rate meant they could only supply half the necessary material. The remaining stone had to be transported from off-site sources, likely located just northeast of the city.

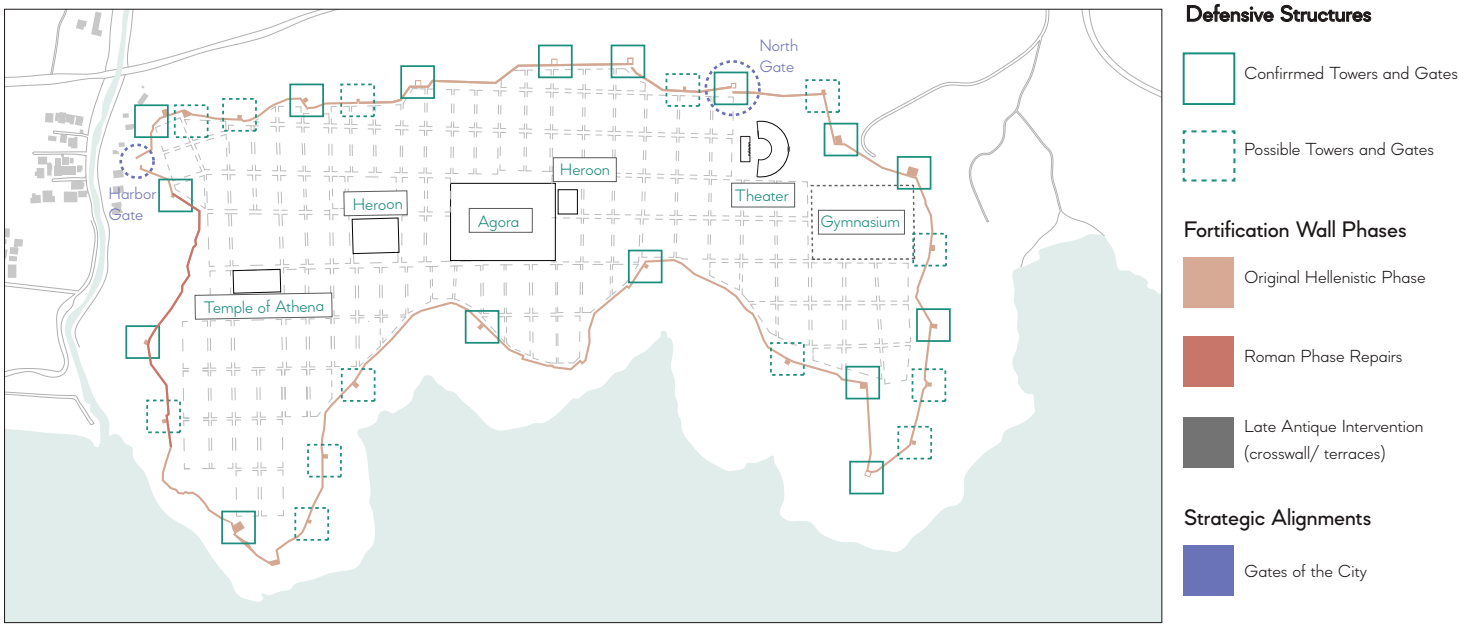


Figure 55. Map of the fortification walls of Notion, illustrating the defensive elements, strategic topography, and distinct construction phases. Diagram by author, based on Ratté, Rojas, and Commito (2017).

62. Ratté, Rojas, and Commito, "Notion Archaeological Survey, 2014-2015," 622-623; "Fortifications," Notion Archaeological Survey, University of Michigan.



Figure 56. Detail of the eastern fortification wall, Hellenistic dry-stone isodomic masonry. Source: Ratté, Rojas, and Commito (2017).

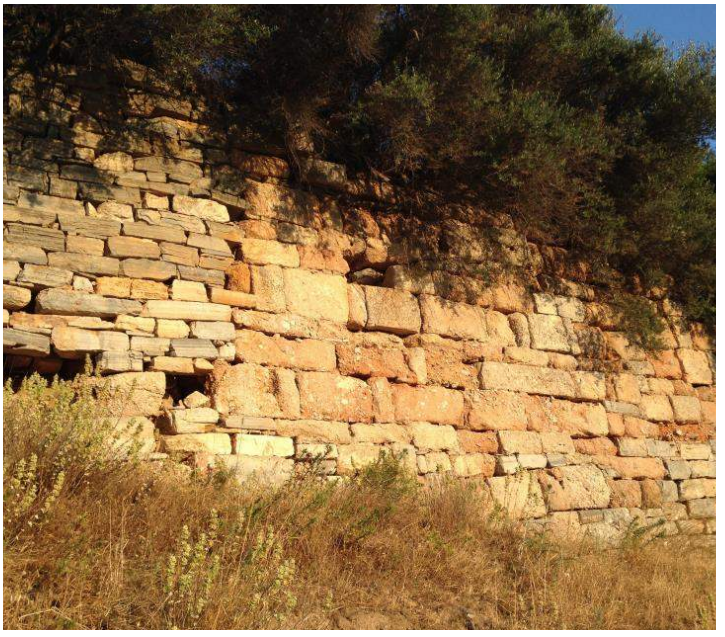


Figure 57. Detail of the western fortification wall showing Roman repairs with spoliated blocks. Source: Ratté, Rojas, and Commito (2017).



Figure 58. Panoramic view of the northern fortification wall after clearing, 2017. Source: Ratté, Rojas, and Commito (2020).

3.3.4 Necropolis

The necropolis of Notion must be considered beyond just a burial ground; but as an intricate, stratified landscape that connects the wider urban territory with distinctive architectural forms. The necropolis defines the extramural zone and structures the city's rural hinterland. The cemeteries are widely distributed across the hills on either sides of the Hales River Valley (Fig. 59). On the eastern side, the necropolis extends along the slopes of the same Mount Korakion and delineates the route connecting Notion to the neighboring Sanctuary of Claros. Meanwhile, on the western ridge the burial areas are situated on the exact same topographical alignment as the city's monumental aqueduct, demonstrating a deliberate urban integration of funerary spaces with major hydraulic infrastructure. Furthermore, the proximity of tombs to the northern fortification walls, illustrates how the necropolis functioned as a dynamic transition zone, smoothly creating a relation the enclosed orthogonal city and its broader territory. Additionally, the necropolis area encompasses a diverse architectural type, including vertically and horizontally carved rock-cut chambers, masonry-built tombs, and monumental tumuli (Fig.60). A notable example is the tumulus on a prominent ridge, features a masonry krepis (a stepped retaining wall) built from small rectangular ashlar blocks, measures around 11 meters in diameter. Additionally, the investigations on the highest level of the necropolis have identified tower-like tomb has sizes 3.3 by 4.2 meters with 90 cm thick-walls and the remainings of the site-access stairs (Fig. 61, 62, 63). The dispersed locations of these visible remains on the high hills on the site, allowed the cemetery to establish its territorial and visual boundaries of the city.[63]



Figure 59. Topographical map illustrating the locations of the eastern and western necropoleis in relation to the urban plan of Notion. Source: Ratté (2024).

63. Schuchhardt, "Kolophon, Notion und Klaros," 425; Laflı, "Notion'dan Yeni Buluntular,": 11. The interpretation of these monumental tombs as territorial and visual boundaries aligns with broader Hellenistic practices of utilizing extramural funerary architecture as strategic landscape markers.



Figure 60. Remains of a monumental tumulus with masonry krepis in the Notion necropolis. Photograph by the author.

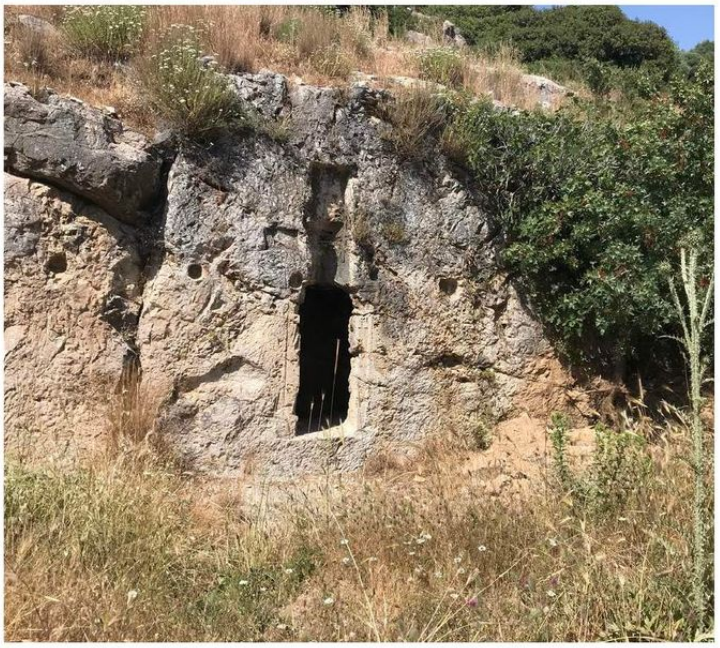


Figure 61. Remains of a tower-like tomb on the upper ridges of the Notion necropolis. Photograph by the author.



Figure 62. Rock-cut staircase providing access to the extramural necropolis of Notion. Photograph by the author.



Figure 63. Monumental tumulus on a prominent ridge in the Notion necropolis. Photograph by the author.

3.4 Main Architectural Complexes

3.4.1 Temple of Athena

Historical Evolution and Building Period

Temple of Athena, located on the highest level of the western promontories was probably defining the silhouette of the ancient city. In the earlier researches, the construction of the temple was dated back to 2nd century during the Hadriannic period, however current researches reveal that it actually belongs to the Late Hellenistic or Augustan Period. This historical period had its own technical and stylistic architectural details, such as pour channels and skull reliefs of the calf. The most remarkable feature is that the temple is the only monumental structure that did not align with the orthogonal urban grid plan (Fig. 64). This deviation of the temple is not related with if the grid planning construction date was earlier than the construction date of the temple, rather it was related to the consideration that on the space Temple of Athena, there was another structure dated back to 5th century BCE during the Bronze Age. Thereby, it provides us to consider that the construction of Temple of Athena during Late Hellenistic/Augustian period followed the placement of the earlier sacred cult structure's axis located on the same area. Therefore, it can be represented that, even though the Temple of Athena was constructed later than the grid planning system, its placement orientation had followed the earlier sacred structure. Consequently this misalignment serves as a reflection of the city's deep rooted historical ties with Athenian religious traditions in the 5th century BCE.

Architectural Features and Current State:

The foundation of the temple was completely built by conglomerate foundations and measures 9.39 by 16.04 meters at the euthynteria level (Fig. 65). However, the structure was designed in the Corinthian order and presents a unique typology featuring two columns "in antis" at its rear facade. At present, the roof and the vertical structural elements of the temple are completely lost (Fig. 66). The main reason f or this destruction is that the architectural blocks of the temple were reused as "spolia" in the defensive tower built on the southwest during the Late Antique or Medieval periods, which was dismantled during the later excavations.[64]



Figure 64. Aerial orthophoto of the Temple of Athena terrace, western promontory. Source: Ratté (2023).

64. Demangel and Laumonier, "Fouilles de Notion (1921)," 362-363; Ratté, Rojas, and Commito, "Notion Archaeological Survey 2017-2018," 4-5.

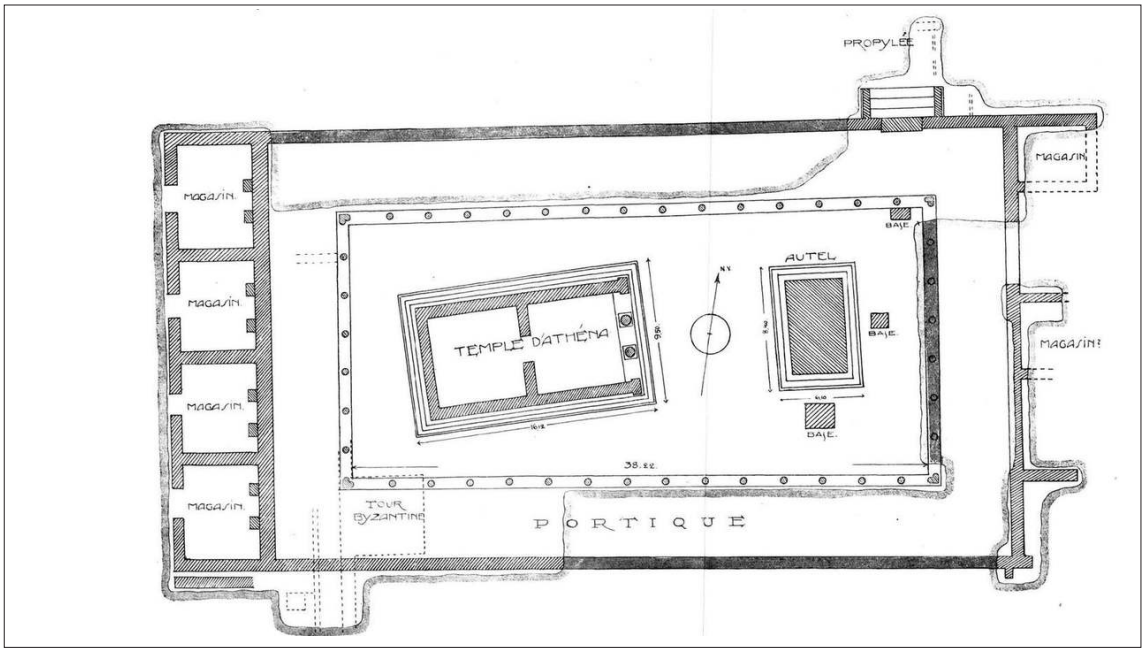


Figure 65. Plan of the Temple of Athena within its colonnaded court. Source: Ratté, Rojas, and Commito (2020).

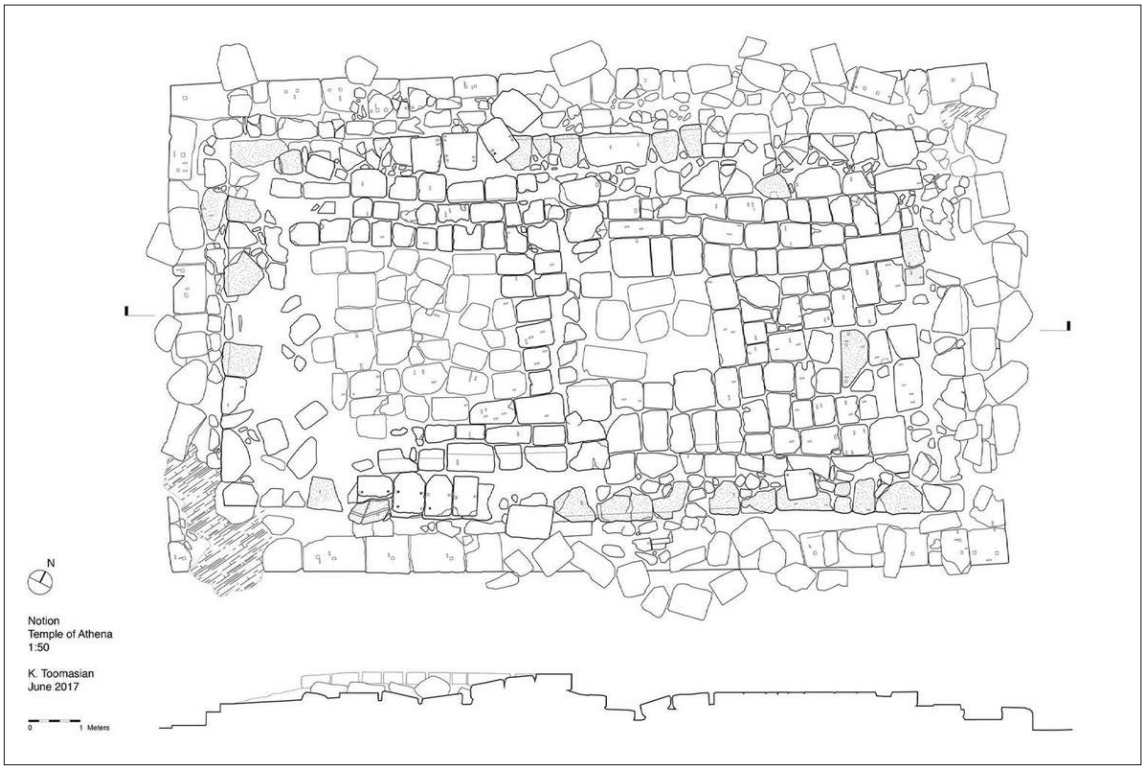


Figure 66. Measured stone-by-stone plan of the Temple of Athena remains (survey by A. Sandelewski, 2019). Source: Ratté (2019).

3.4.2 Heroon



Figure 67. View of the remains of the Heroon, with scattered marble blocks among the vegetation. Source: Ratté (2019).

Historical Evolution and Building Period

Located 160 meters east of the Temple of Athena (Fig. 67) and just west of the Central Agora, this 2nd-century BCE structure perfectly aligns with the grid planning of the city (Fig. 68). In terms of its historical use, architecturally, the building's underground chamber is highly significant. While it can be strongly associated with underworld rituals or hero cults, where the opening served primarily to pour libations instead of human physical access, some scholars suggest it might have functioned as a lesser urban oracle. Furthermore, this configuration draws strong architectural resemblances with the oracle center at the nearby Sanctuary of Apollo at Claros, leading to alternative identifications of the structure as a Temple of Apollo or even a Metroon, based on reused inscribed blocks dedicating the space to the priestesses of Aphrodite and Meter Antaia. Spatially, the temple did not stand alone; it was placed within a broad, rectangular sanctuary enclosure (*temenos*) measuring 64.9 by 48.7 meters. This space was enclosed by colonnades on the north, east, and possibly south sides, and it included a small rectangular exedra to the southeast. This arrangement illustrates a common Hellenistic design principle; the placement of the small structure within such a broad colonnaded enclosure demonstrates how the Hellenistic grid accommodates sacred spaces while maintaining clear boundaries between religious and civic realms.

Architectural Features and Current State:



Figure 68. Orthophoto of the Heroon. Source: Ratté (2019).

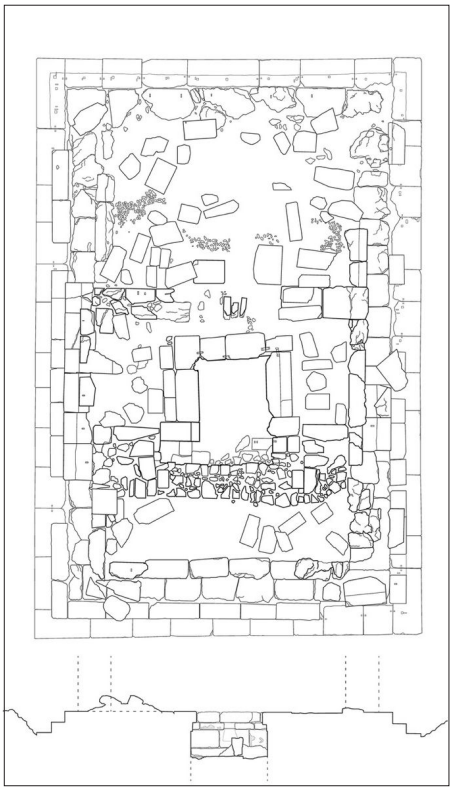


Figure 69. Plan of the Heroon. Source: Ratté (2019).

The material used in its construction resembles the Temple of Athena, utilizing the conglomerate foundations supporting the marble superstructure. However, unlike the Temple of Athena, the bedrock beneath the Heroon is nowhere exposed, instead the structure built by conglomerate euthynteria is much more solidly built in 9.84 m by 14.92 meters (Fig. 69), and it was divided into two rooms by a crosswall. Currently, this marble superstructure has completely disappeared. Therefore, the marble structure of Heroon has uncertainties relating if it had a columnar porch or a simple "oikos". Moving to its interior, the most notable architectural characteristic is the underground chamber (crypt) situated beneath the western rooms, constructed using finely cut conglomerate ashlar blocks. This crypt measures 2.15 meters from east to west and 1.98 meters from south to north, with 1.74 m depth. In order to access this subterranean space, an opening from the top is provided as a trapdoor. Spatially, the temple was not standing alone, it was placed in a rectangular sanctuary enclosure (temenos) with the 64.9 by 48.7 meters dimensions. Additionally, this space was enclosured by colonnades on the north, east and possibly south sides; and it included a small rectangular exedra to the southeast.[65]

65. Büyükkolancı, "1994 Yılı Notion Kazıları," 372–373.; Ratté, "The Sacred Architecture of Notion," 6-7. The total depth of the crypt remains undetermined due to unexcavated debris, and the complete loss of the marble superstructure precludes a definitive reconstruction of the building's facade.

3.4.3 Peristyle House (West Ridge House)

Historical Evolution and Materiality

The residence is located on the west of the Agora, and has a layered structural history. The Hellenistic residence had 18 m by 18 meter dimensions aligned the city grid. However, the construction dates from the mid 2nd to 1st centuries BCE, fully conforms to the orthogonal grid plan. However, the excavations beneath the floor levels uncovered 5th century BCE, and the classical foundations were revealed with different, oblique directions. This earlier phase was firmly dated by the discovery of a hoard of 50 Persian gold darics hidden beneath the courtyard. This drastic shift in orientation illustrates the implementation of the Hellenistic grid, demonstrating that the new civic master plan was prioritized over the preexisting property lines. Regarding, the materials used in the construction of the house are local marble blocks and small packing stones. Additionally, the upper walls were built by mudbrick, and the building was covered with a terracotta tiled roof. The combination of sturdy stone foundations and lightweight mudbrick upper walls demonstrates a well adapted technique to the local environment.[66]

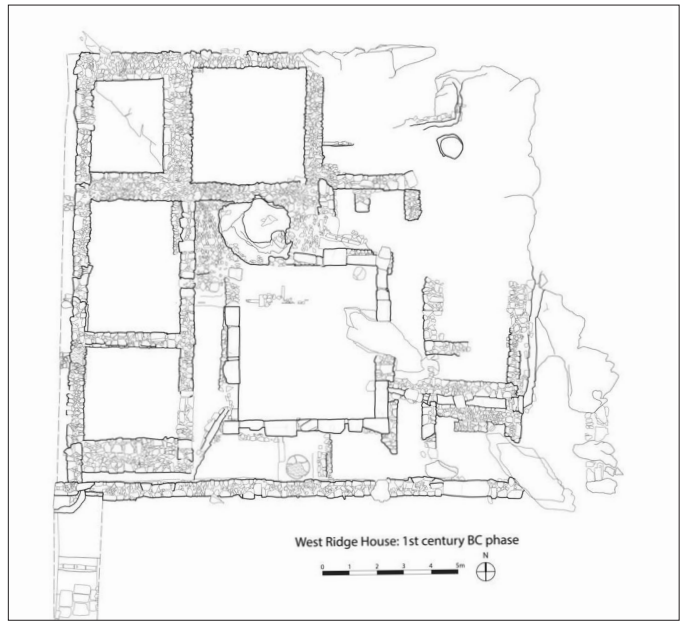


Figure 70. Stone-by-stone plan of the Hellenistic peristyle house (West Ridge House). Source: Ratté (2025), fig. 11.

Architectural Features and Current State

The excavations carried out in the residential areas focused on a large Hellenistic peristyle house on the West Ridge (Fig 70). At present, for the building located on the summit of the central ridge, only the foundation level and subfloor systems remained. The original floor surfaces and mudbrick upper walls have been completely lost throughout the centuries. Spatially, the residence is organized around a central peristyle courtyard measuring 5.8 m by 6.5 meters. This open space is limited by porticoes on three sides and surrounded by seven rooms in total.

The distribution of the artifact findings allowed the team to identify the daily uses of the spaces within this house; for instance, the northwestern room served as a kitchen while findings of fine tablewares made the team consider the eastern was functioning as a pantry. The other remarkable feature of the house is that underground water management infrastructure, which includes a subterranean drainage system of terracotta pipes, pithoi, and a large rock-cut cistern located northwest of the courtyard. This demonstrates that the residential houses provided their own water management system throughout the city. Nevertheless, these structural remains provide crucial historical data. Beneath the Hellenistic constructed layers, archaeologists uncovered a well-preserved Classical period layer dating to the late 5th BCE. The investigations on the foundation of the peristyle house is a demonstration of the urban transformation of the city. This means that the building's overlapping layers act as tangible evidence of how the city's master plan changed; it obviously emphasizes how the Hellenistic grid system was imposed directly over the older, irregularly oriented Classical settlement (Fig. 71, 72).[67]

66. Christopher Ratté, "Fieldwork at Notion in 2023, Final Report," Notion Archaeological Project (2023), 5, 8-9; Christopher Ratté, "Fieldwork at Notion in 2024, Final Report," Notion Archaeological Project (2024), 6-7. The discovery of the darics hoard within a local vessel provides a firm late fifth-century BCE terminus ante quem for the underlying Classical structure, historically correlating with the turbulent period of Athenian and Persian factional struggles at Notion without necessitating direct reliance on ancient literary narratives.
67. Ratté, "Fieldwork at Notion in 2023, Final Report," 5-6.



Figure 71. Color-coded orthophoto of the West Ridge House illustrating different building phases. Source: Ratté (2025), fig. 10.



Figure 72. Wall layers from different historical eras in the Peristyle House. Photograph by the author.

3.4.4 Bouleuterion



Figure 73. View of the Bouleuterion, overlooking the sea. Photograph by the author.

Historical Evolution and Materiality

The location of Bouleuterion is at the northeast corner of Agora, serving as the main administrative center of the city's political apparatus. Its principal function was to host the meeting of the city council, providing an indoor solace where the political debates were conducted and official civic decisions were formally legislated (Fig. 73, 74).

The construction dates to the late 3rd and 2nd century BCE, even the building underwent major spatial modifications during the Imperial period. Especially, an in-situ statue base dedicated to Augustus discovered in the orchestra, with an epithet "Bringer of Reconciliation" (Kaisar Hilasterios) (Fig. 75, 76). Thereby, it can be said that there has been a significant Augustan refurbishment on the Bouleuterion orchestra. Besides, its exterior walls were constructed by meticulously clamped and doweled marble blocks; while the inside of the building, the auditorium were carved directly from local conglomerate rock. Significantly. these conglomerate seats and the floor of ambulatory were supported by the rammed-earth core, which was stabilized by a series of internal and external retaining rubble walls forming an advanced "chain wall" system. Furthermore, the entire structure was covered by the terracotta tiles, now it is evidenced that the extensive tile debris lays on the auditorium ground.

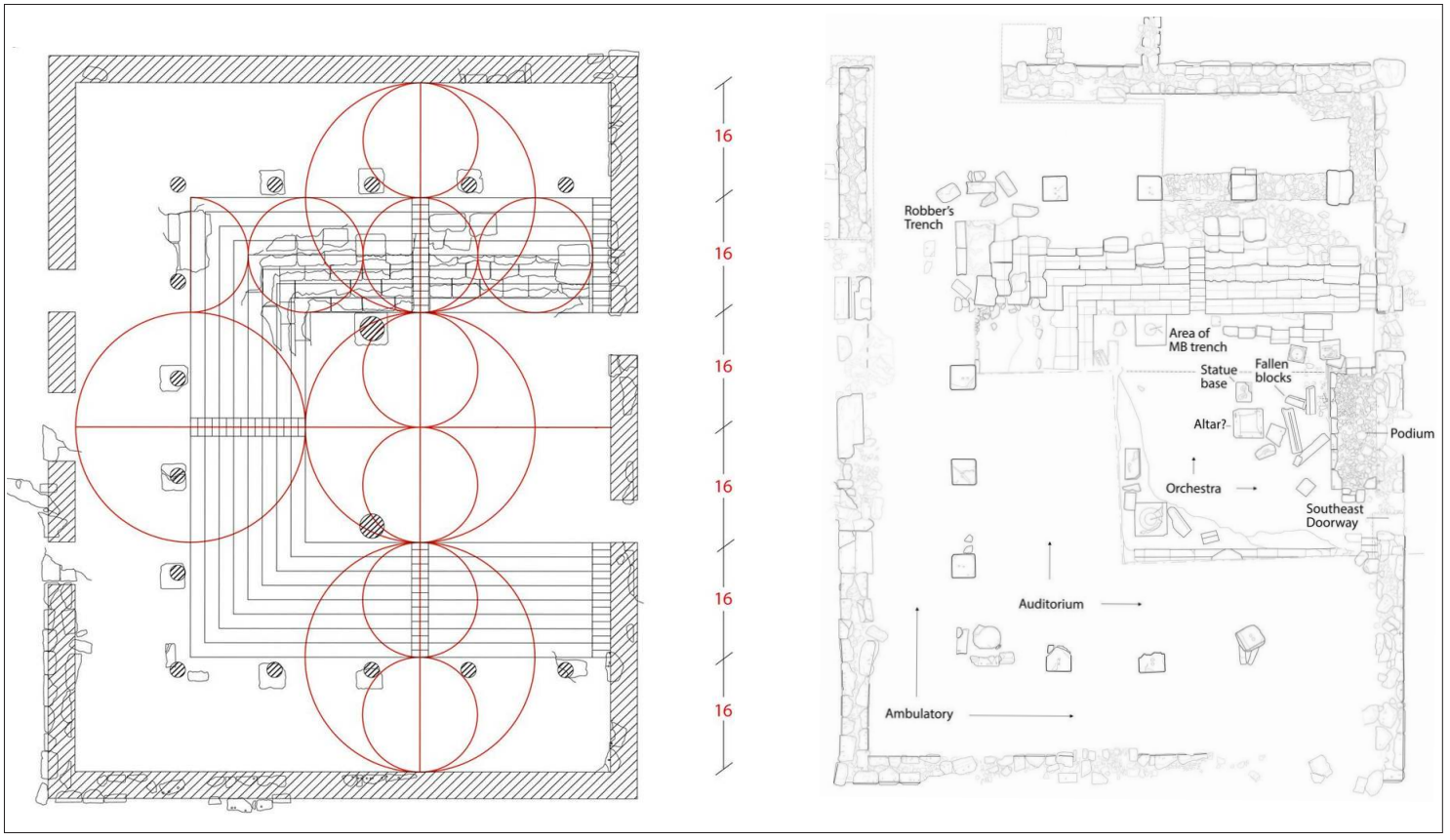


Figure 74. Bouleuterion at Notion: Original restored plan (left) and current survey plan (right). Created by the author based on Ratté et al. (2022).

Architectural Features and Current State

The design of the Bouleuterion based on geometrical proportions. The spatial organization of Bouleuterion is based on a module of 16 Ionic feet, which defines the width of the ambulatories and the seating areas. With dimensions of 30.5 meters from north to south and 24.2 meters from east to west, it is one of the largest known Hellenistic rectangular council houses. Additionally, the building consists of an east-facing U-shaped auditorium that could accommodate approximately 500 people, a central orchestra, and a broad ambulatory surrounding the seating area on three sides. The difference in elevation between the higher western side and the lower eastern side of the building is 2.1 meters. The auditorium seating is bordered by 13 stairways, defining 12 cunei (wedge-shaped seating sections) containing at least 13 rows of seats. Between the ambulatory and the auditorium, a series of 14 conglomerate columns served as structural elements to support the roof, along with two additional large columns placed in the western corners of the orchestra. There are also major entrances on the eastern wall, including a recently excavated southern doorway. Currently, the Bouleuterion is one of the best-preserved structures within the city, although its upper marble walls and monumental roof have collapsed over time.[68] Ongoing conservation and excavation efforts aim to transform this structure into a major focal point for visitors, displaying its remarkably transparent Hellenistic design.

68. Ratté, "Archaeological Research at Notion, 2022-23," 342; "Notion Newsletter 01," Notion Archaeological Project (2024), 2. The strict application of the 16-Ionic-foot module within an overall length of approximately 100 Ionic feet indicates that the Bouleuterion was conceptually designed as a hecatompedon.



Figure 75. View of the excavated remains in the civic centre (Bouleuterion area): Statue base with ΚΑΙΣΑΡΟΣΙΛΑΣΤΗΡΙΟΥ written on it : Kaisaros Ilasteriou; "of the expiatory offering of Caesar." Photograph by the author.



Figure 76. View of the excavated remains in the civic centre (Bouleuterion area): Statue base with stolen statue's footprints. Photography by the author.

3.4.5 Agora



Figure 77. Aerial orthophoto of the Agora of Notion. Source: Ratté, Commito, and Knoop (2018).

Historical Evolution and Materiality

The Agora is located in the middle of the city, serving as its primary commercial and civic center. The construction of the Agora dates back to the Hellenistic refounding of the city (late 3rd to 2nd centuries BCE) and had required the carving of the native bedrock to create a massive leveled terrace at an elevation of 59 meters above sea level, in order to overcome the challenging topography (Fig. 77). However, this extensive leveling operation effectively functioned as a vast open-air quarry, which removed the earlier settlement layers to prepare the site for the new civic center. While nearby buildings, such as the Bouleuterion, utilized conglomerate in their construction, the Agora features a significant use of marble for its structures. Ultimately, the quarrying and soil removal operations on topography to built up the Agora, firmly embedded the building within the Hellenistic orthogonal grid plan. While its intial construction date was defined in the Hellenistic period, the archaeological evidence suggests that the building had continued to serve also during the Roman Imperial era.

Architectural Features and Current State:

The building had a rectangular form measuring 130 m by 97 meters, while the interior dimensions are 114.3 by 71.8 m; which represents a ratio of 3:4 based on 330 by 440 Ionic feet. The central open area was surrounded by colonnaded porticoes (stoas) on all four sides. The western stoa is double-colonnaded, while the northern stoa is a single colonnaded space opening into a row of shops. Besides, the southern facade adapts to the terrain's steep slope by featuring a split-level structure, which is a double colonnaded stoa; its upper level opens directly onto the square of the Agora, while the lower level faces an east-to-west street situated 2.5 meters below. The eastern stoa was single colonnaded, situated directly in front of the Bouleuterion. At present, the Central Agora remains unexcavated and covered by vegetation. Nevertheless, recent non-invasive archaeological investigations, such as magnetic surveys, have revealed the subterranean features of the building, including the shops of the northern stoa, an east-west axis drainage line through the center of the square, and traces of a possible monumental foundation (likely an altar or a small shrine) in the eastern half of the square.

3.4.6 Gymnasium



Figure 79. View of the Gymnasium area in the eastern part of the city, beside the eastern fortification. Photograph by the author.

Historical Evolution and Materiality

It is located on the eastern part of the city, near to the eastern fortification wall. Regarding its urban configuration, the Gymnasium was designed within the orthogonal grid plan. Its alignment with the grid system ensures that the construction date can not be earlier than the early 3rd century BCE, which highlights the Hellenistic refounding of the city, the new implementation of the urban grid layout. The building served as a vital public institution that combined the athletic training with civic education and social interaction.

The epigraphic evidence provides an important historical context regarding the two groups that utilized the facility. An inscription discovered in 1904, refers that the two distinct gymnasia at Notion, one dedicated to the "young men" (neoi) and the another to "adolescents" (ephebooi). It can be suggested that both of the institutions eventually combined into the single monumental Gymnasium at this location.[69] This combination of the separate educational groups into single, massive complex reflects a significant spatial evolution of the Notion's civic institutions over time. Besides, the construction material and techniques of Gymnasium, remained unconfirmed, since the gymnasium area has not been excavated yet. Nevertheless, it can be considered that the construction material could be preferred as local stone as typical of Notion's other monumental structures.

69. Christopher Ratté, "Ankara Report 2023," Notion Archaeological Project (2023), 11; Macridy, "Altertümer von Notion," 162-163. The hypothesis that the two distinct gymnasia for neoi and epheboi were consolidated into this single monumental complex is supported by both the epigraphic record and the massive scale revealed by recent geophysical surveys.

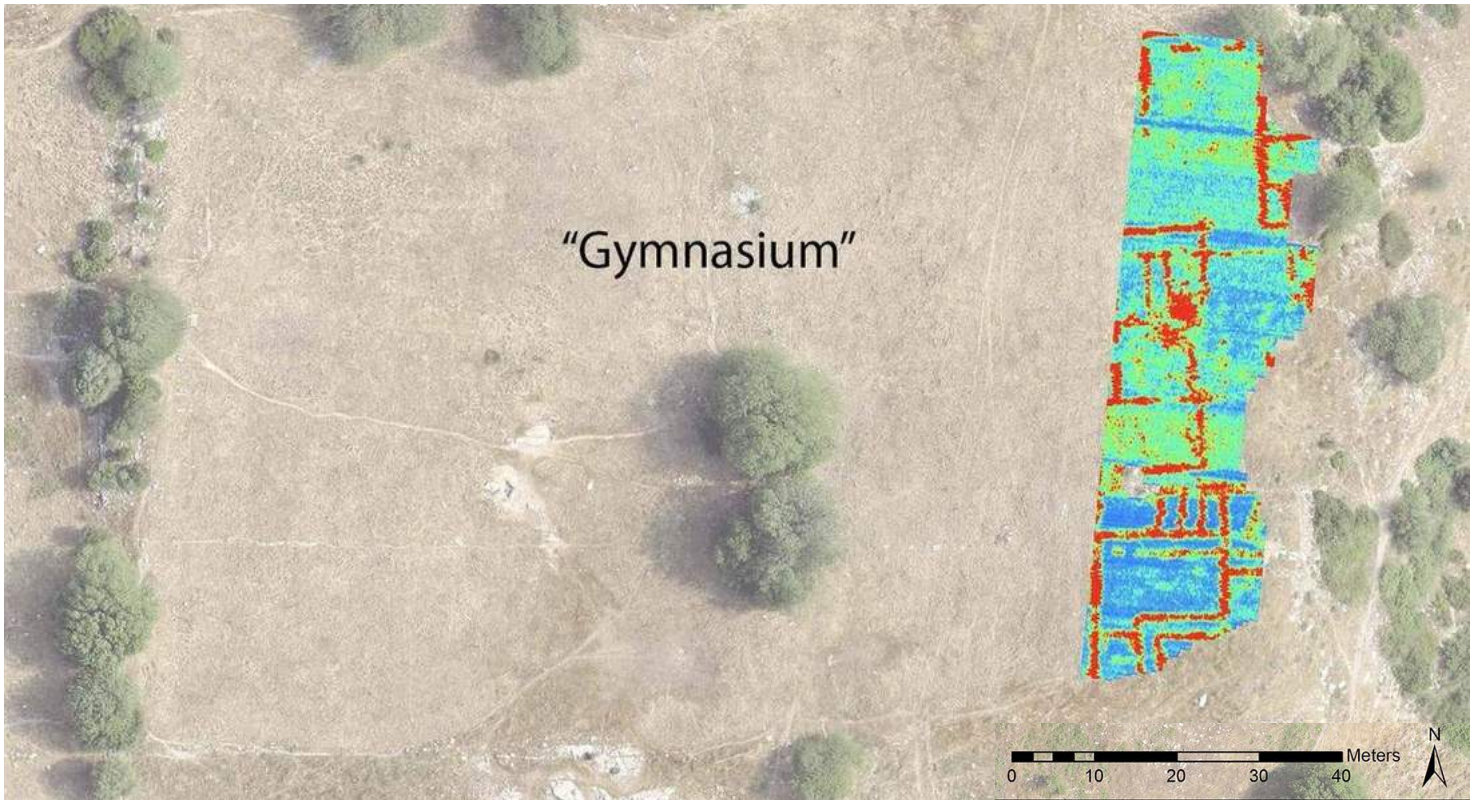


Figure 80. Orthophoto of the Gymnasium with GPR survey results. Source: Ratté, Rojas, and Commito (2020).

Architectural Features and Current State:

Currently, the area is unexcavated and overgrown with flora (Fig. 79), presenting very few visible surface remains. Ground Penetrating Radar (GPR) has revealed the floor plan of the building plan hidden beneath the surface. It is assessed that the wall remains at the depth of 0.5 to 1 meters. The geophysical data reveals that on the east side there is an existing large meeting rooms (Fig. 80). Furthermore, a central block measuring 5 m by 8 m consists of small inner rooms, located in the middle of the Gymnasium space creates two distinct, broad courtyards on the plan. This spatial organization of the layout strongly suggests the structure functioned as a major public education and athletic facility, consistent with the requirements of the ancient city.[70]

Spatially, the Gymnasium was deeply integrated into the surrounding urban fabric. It was bordered by an east-west street running along its south side, while the descending slope to the west, towards the Agora, was densely filled with residential houses built on stepped terraces. Furthermore, the GPR surveys revealed additional buried features immediately to the east of the Gymnasium, including what appears to be the northwest corner of another large courtyard structure, hinting at a broader interconnected public building complex. Ultimately, because these structural remains are buried at a shallow depth, they are expected to yield better than usual preservation, making the Gymnasium a highly promising location for future archaeological excavations.

70. Ratté, "Fieldwork at Notion in 2023, Final Report," 11; Christopher Ratté, Felipe Rojas, and Angela Commito, "Notion Archaeological Survey 2017-2018" (University of Michigan, 2018), 2.

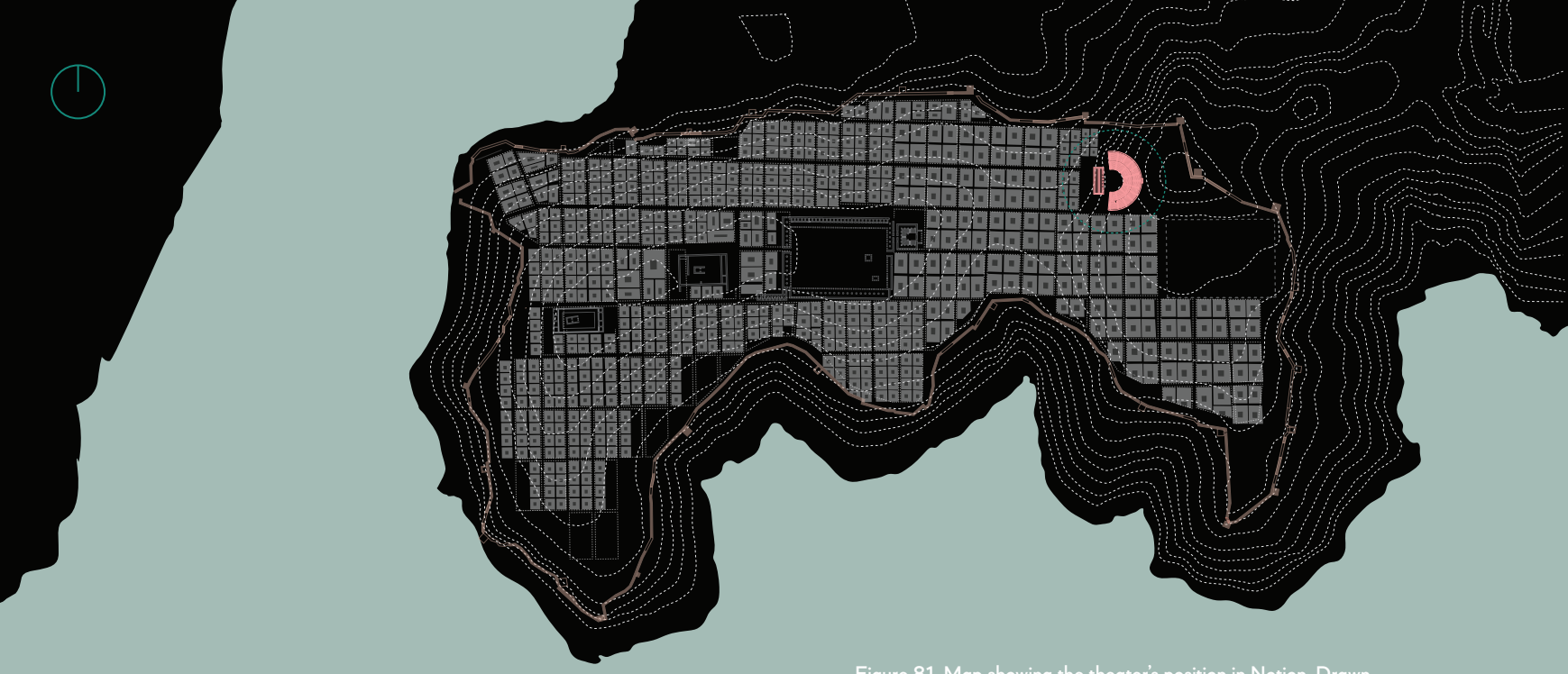


Figure 81. Map showing the theater's position in Notion. Drawn based on Ratté (2019).

3.5 Theater: The Primary Case Study

Notion Ancient Theater situated on the eastern hill, in close proximity to the highest peak of the city (Fig. 81). It was built directly into the natural slope of the terrain, strategically positioned to minimize the need for massive supporting masonry such as retaining walls (analemmata), which reflects a typical feature of Greek theater design. The use of topography as a structural component was a fundamental approach in the Classical and Hellenistic period engineering. However, the most rational method for the construction of the ancient Greek theaters was placing the cavea on the sloped terrain (Fig. 82). While Romans typically built theaters on the flat terrains using massive arch and vault infrastructures, the Hellenistic theater constructions utilized the natural inclination as the structural support, transmitting the load directly to the inclined terrain. The certain construction date of the theater remains still uncertain, however the building construction dated to the Hellenistic period during the 2nd century BCE. Although the city was eventually incorporated into the Roman province of Asia, the theater at Notion notably lacks typical Roman imperial modifications. Unlike the many other theaters in the Asia Minor, the theater in Notion's structure likely lacks the decorations on the stage building (scaenae frons) and vaulted lateral passageways (paradoi). The absence of Roman imperial modifications in theater demonstrates that the theater maintained its Hellenistic characteristics until the city was largely abandoned in the 1st century CE, without the modification in the later historical phases. Furthermore, the design of the theater had prioritized its functionality, as accommodating up to half of the city's population, so that it served as a vital gathering space in the city with an offering panoramic view of the Aegean Sea.



Figure 82. View of the theater and its olive-grove landscape. Photograph taken from Bouleuterion. Photograph by the author.

Architectural Features

The ancient Greek theater features a slightly greater semicircular plan with a diameter of 70 meters. The seating area (cavea) has a %30 inclined terrain and it is divided by the single horizontal walkway (diazoma). The cavea contains at least 23 seat rows; the 9 rows were situated in the lower cavea and at least 14 rows in the upper cavea. Besides, the circular orchestra measuring 27 m in diameter is existing with backing to the rectangular stage building (skene) with dimensions of 12 by 32 meters (Fig. 83). [71]

The theater has the remaining vaulted substructure beneath the southern cavea that still survives to the present day. Even though the theater was constructed directly into the sloped territory in order to minimize the material use for structural support, these substructures were strategically utilized to specific sections of the cavea. The vault helps to relieve stress and acts as a structural element on the cavea, also plays a crucial role to transmit the loads among the cavea's structure. Unlike the decorative and monumental arches commonly associated with the Roman theaters, these vaults were constructed only to create a bridge between the elevation differences on the sloped terrain, and securely transfer the dynamic loads of seating steps to the bedrock beneath of the cavea. It is significant to distinguish this functional subfloor vaults from the monumental, vaulted lateral passageways (parodoi) which are the characteristics of later Roman theaters.

In the recent archaeological investigations, the laser scans indicate that the theater accommodated around 3500-4000 spectators. However, this number points out the theater could host at least one to third of the total estimated population, which highlights its vital civic and social importance within the city.

71. Ratté, Rojas, and Commito, "Notion Archaeological Survey 2017–2018," 4–5.

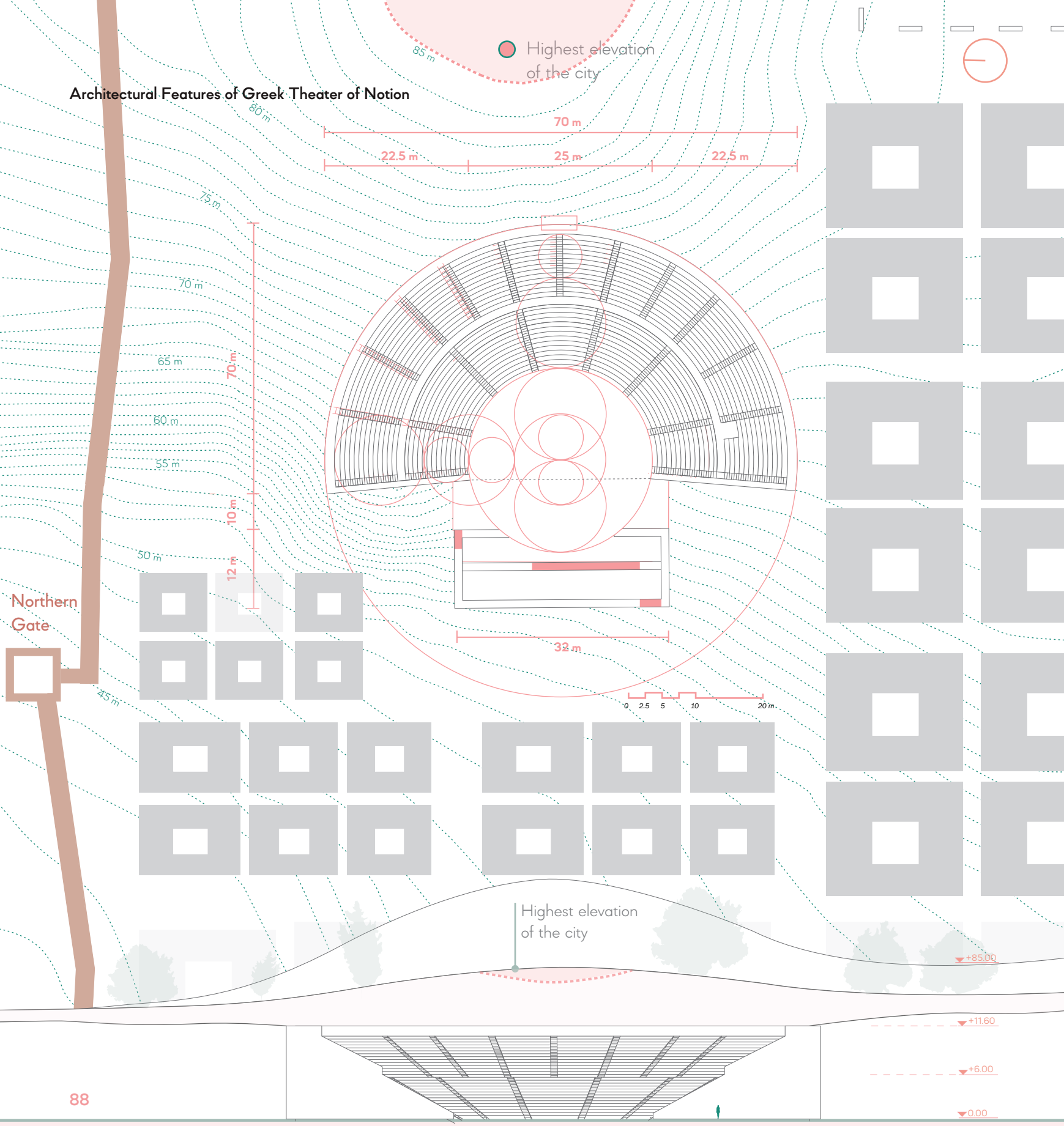


Figure 83. Reconstruction plan and section of the theater at Notion. Drawn by author, adapted from Ratté, Commito, and Knoop (2018), fig. 15.



Figure 84. Conglomerate stones used in the ancient theater. Photograph by the author.

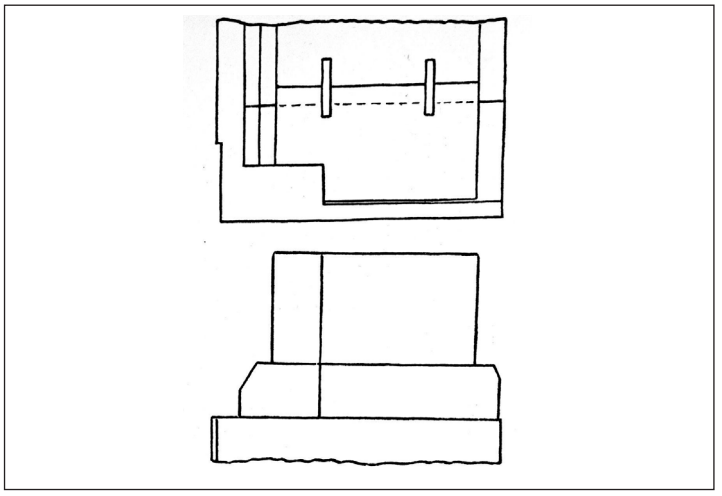


Figure 85. Diagram of clamp connections. Source: Martin (1965).

The construction material of the theater represents quite a homogeneous material choice, conglomerate (Fig. 84). Since transporting such massive volumes of stones was a tough logistical operation for a steep and tough topography, utilizing the local quarries to obtain material could be an option for the construction of the theater. Nevertheless, it is investigated that the geological mapping of the city, and identified that there is no existing large conglomerate quarry within the city to meet the high demand for the construction of Notion's theater. It is detected just a quite small conglomerate stone quarry within the city's north fortification walls, not exceeding 10 meters in total length.

A strong possibility of extracting the conglomerate stones from external quarries located off city limits, likely from the east or northern side of the city, beyond the modern road leading to Ephesus. It can be considered that the off-site extracted stones were subsequently transported to the city for the use of constructions within the city. Additionally, both the cavea stones and retaining walls (*analemmata*) were constructed by the conglomerate stones. These blocks placed on the bedrock of the cavea terrain and were tightly clamped and doweled together. This entirely mortarless "dry stone" (ashlar) technique was preferred, differing from the Roman construction techniques as *Roman opus caementicium* (concrete) or lime mortar. In order to ensure the rough conglomerate blocks fit together without gaps, likely the *anathyrosis* technique was applied as it was common in the Hellenistic theater constructions. This application of anathyrosis involved preparing the contact surfaces of stone blocks in two distinct ways. The stonemasons did not smooth the entire joining block faces; polishing the whole surface was taking much more time and created an extra friction and making it tough to push the heavy stones together. Instead, the stones were smoothed a narrow border around the edges, leaving the central areas of blocks rough and slightly hollowed out. This method helped to make it easier to push the heavy stones tightly together. In this interlocking system could be commonly observed in the many monumental Greek structures comparatively, such as the Parthenon in Athens and the Temple of Zeus in Olympia utilized "double T clamps", while in the beginning of 4th century BCE the practical Π-clamps (Pi-clamps) became widely used, as in the Temple of Asclepius and the Thymele at Epidaurus.[72] Accordingly ancient theater of Notion reflects the continuation of this Greek engineering technique (Fig. 85). Likely, the most critical aspect of this system was pouring the molten lead around the metal fasteners to prevent iron from the oxidizing and fracturing the stone. This technique was also assessed as a vital seismic isolator in the Aegean region that has the earthquake prone. The flexibility provided by the lead aimed to prevent crackings of slightly fragile conglomerate stone against the dynamic loads. Moreover, these lead-sealed clamps were likely placed at the very back of the blocks so that the overlapping step above would completely hide them, maintaining the visual integrity and seamless aesthetic of the cavea. According to the latest investigations on the theater, the estimated volume of the conglomerate stone utilized in the cavea was approximately 3260 m^3.

72. William J. Anderson and R. Phene Spiers, The Architecture of Ancient Greece: An Account of Its Historic Development (London: Batsford, 1902), 102–108. See also: for -π clamps, Dinsmoor, The Architecture of Ancient Greece (1950).

Axonometric View of Theater

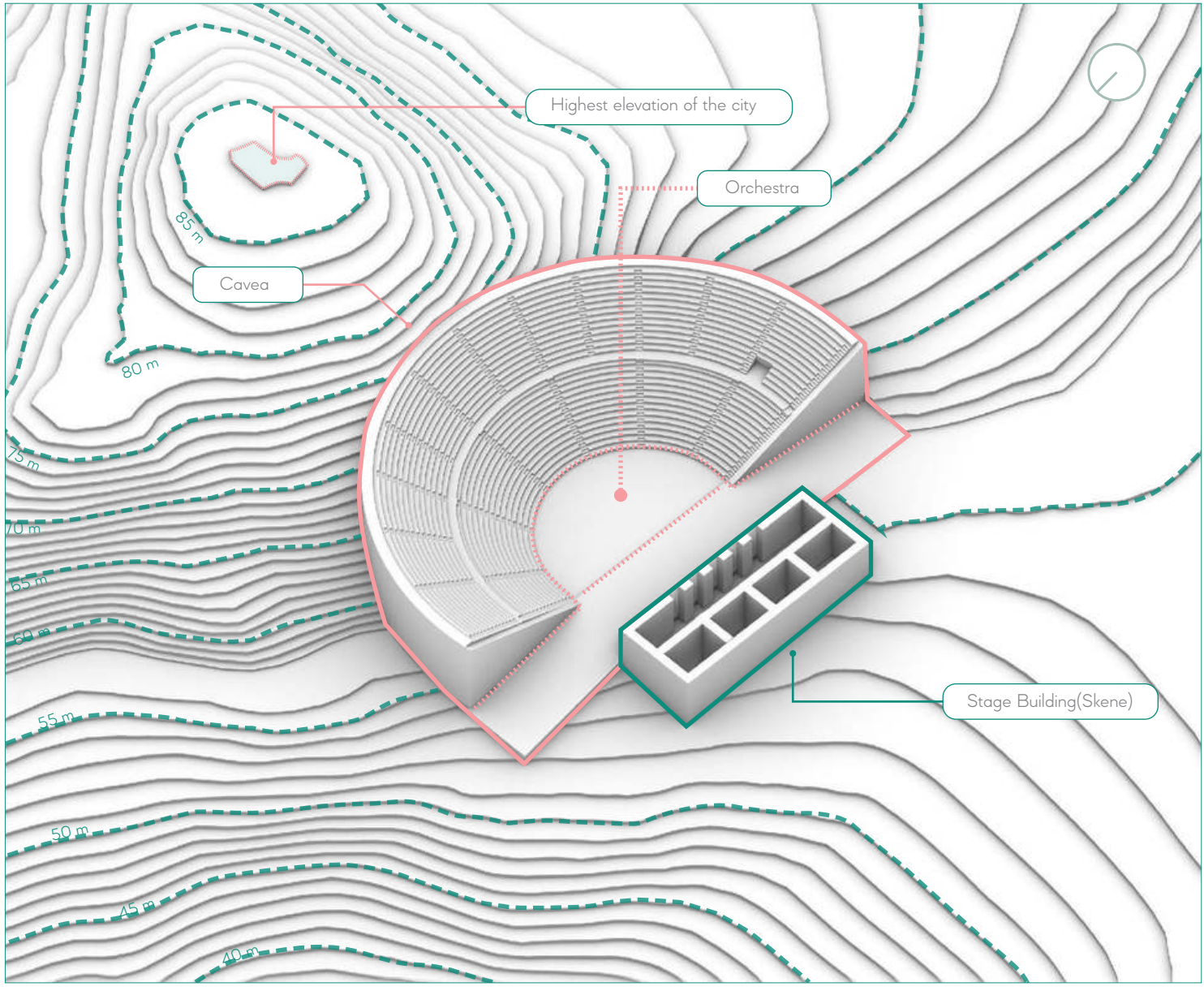


Figure 86. Axonometric of the theater within the site topography. Drawing by the author.

Section of Theater

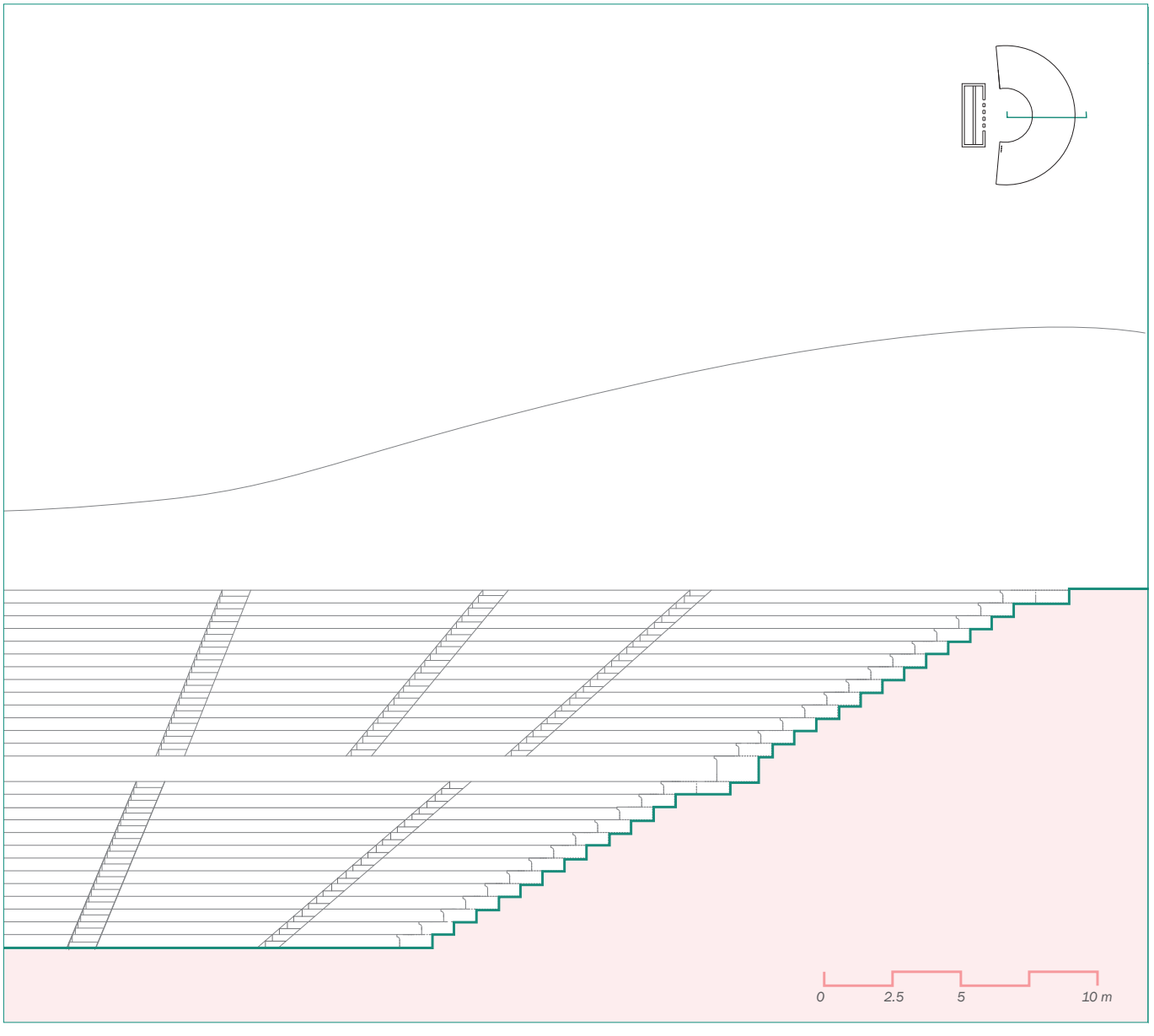


Figure 87. Section / elevation of the ancient theater (Reconstructed). Drawing by the author.

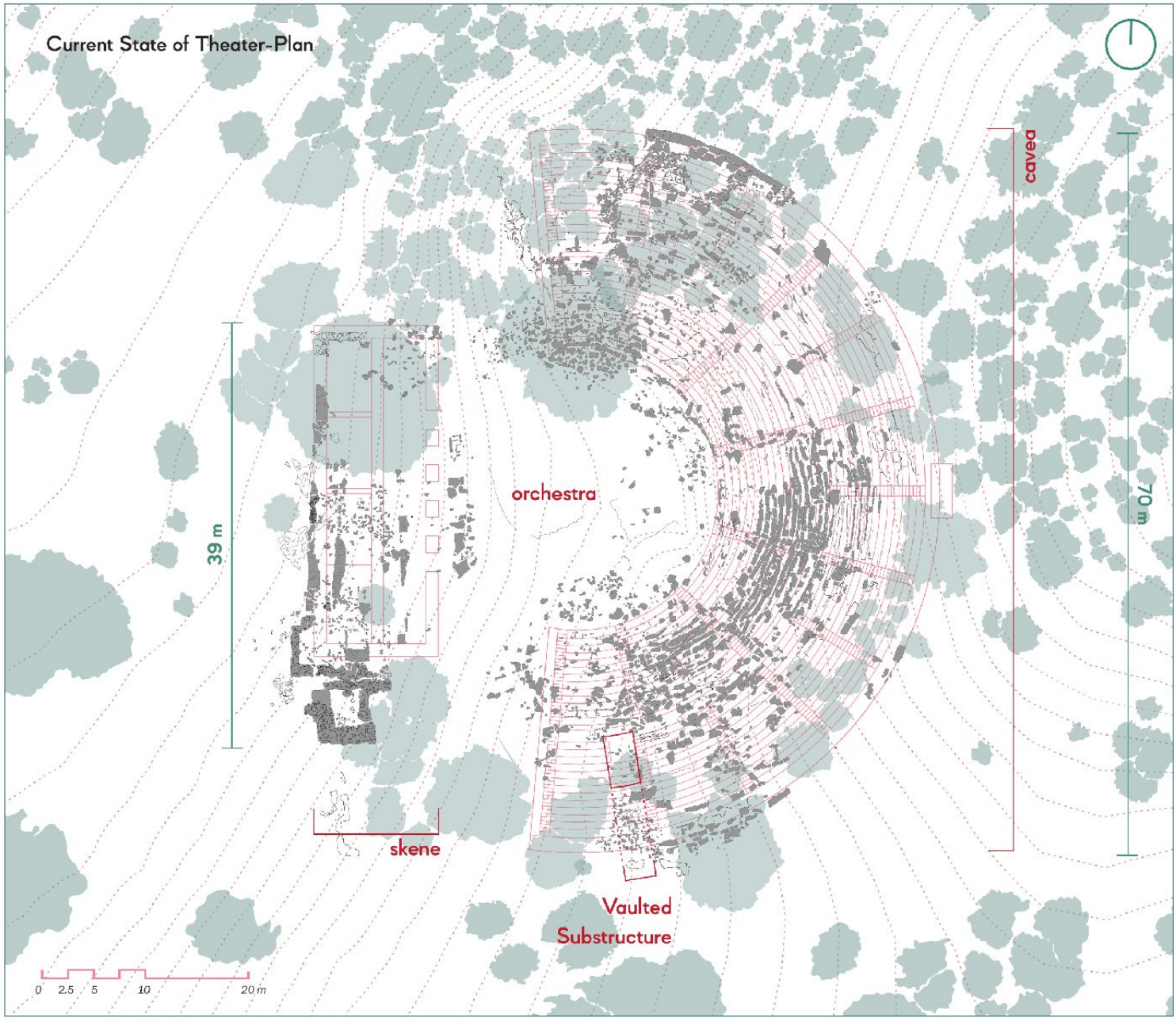


Figure 88.Current State plan of the theater showing overlay with the reconstructed plan. Drawing by the author.

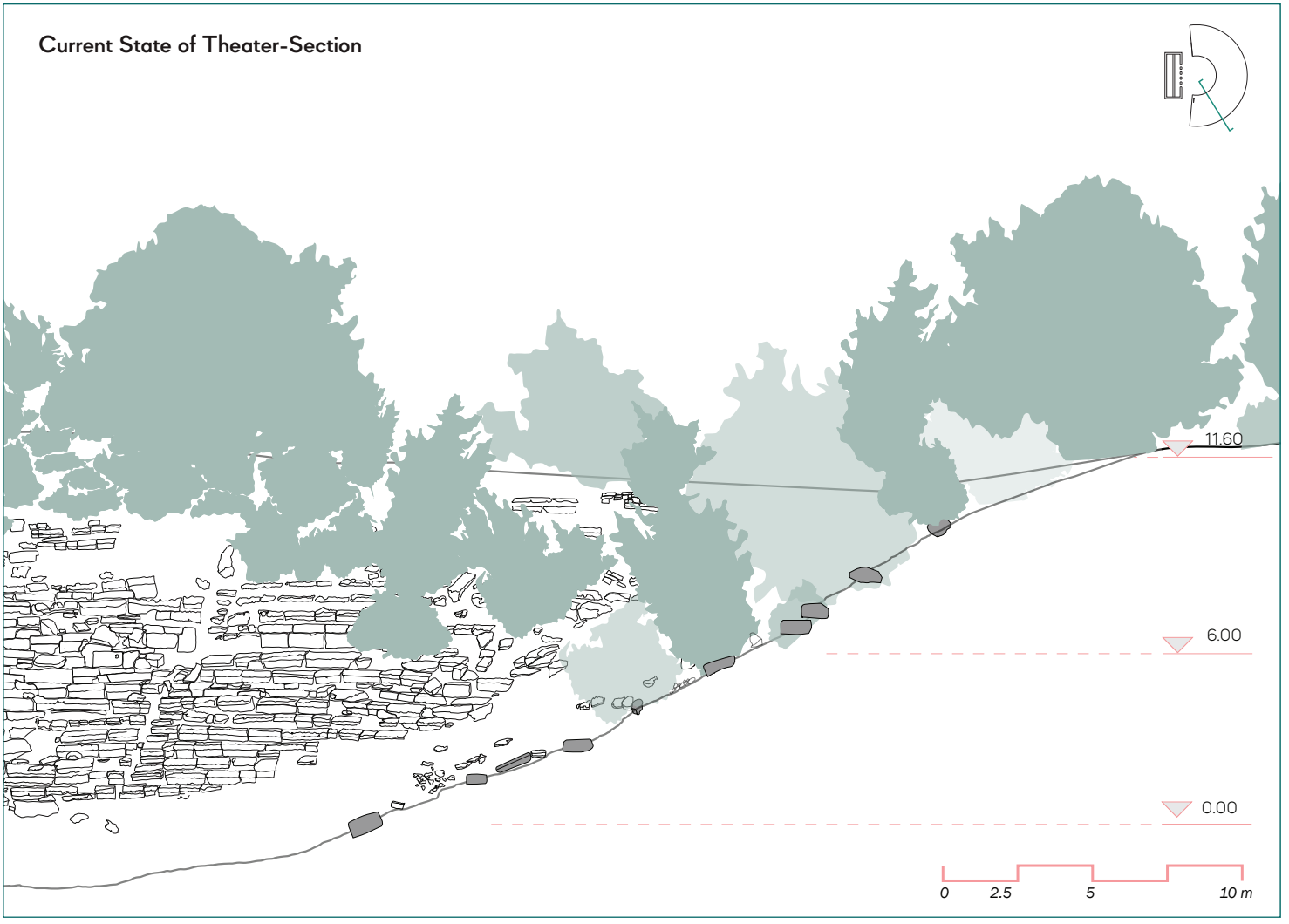


Figure 89. Section of the theater in its current state, with vegetation. Drawing by the author.

Current State and Conservation Challenges

At present, the cavea blocks are severely displaced or dislocated (Fig. 88, 89). A significant number of the blocks are no longer aligned with the original architectural plan, and have lost their original positions. Furthermore, the archaeological investigations point out that the many blocks were intentionally dismantled and repurposed as "spolia". Thereby, it can be referred to that the observed topographical collapse on the cavea's section is likely one of the primary effects of the drastic delocalization and destabilization of the stone placements. (Fig. 90-95)

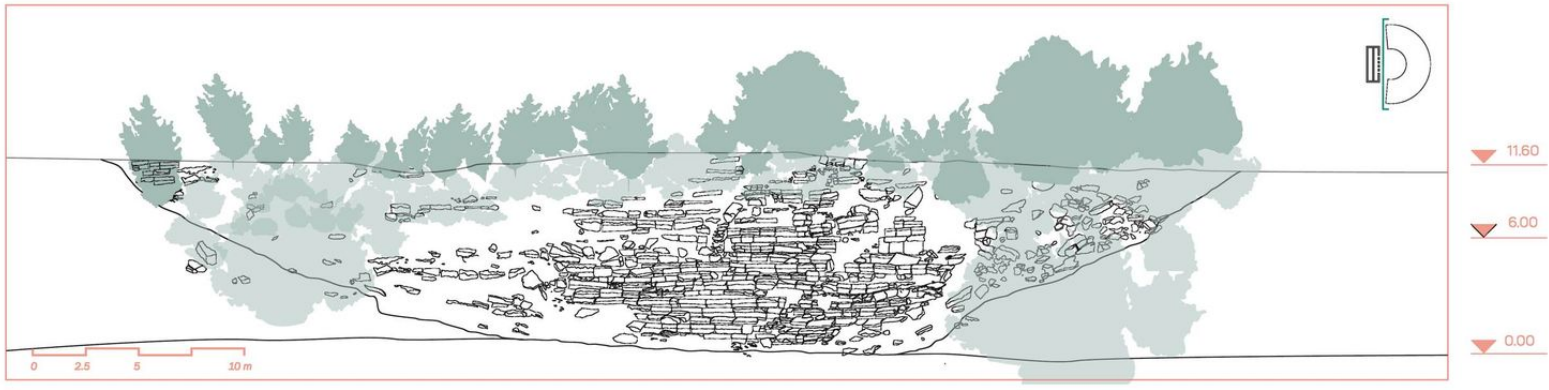
The lack of mortar use in the theater construction caused easier dismantling of the blocks since the valuable metal clamps were removed or looted. The vast majority of the stage building remained unexcavated, still buried under the natural debris, heavily obscured by dense vegetation. As an archaeological ruin, the theater shares a deep symbiotic relationship with the surrounding vegetation. Although this vegetation acts as a *patina of time* that contributes to the site's landscape identity, its mechanical threat to the masonry cannot be ignored. [73]

73. Erol Atalay, "1985 Yılı Notion Kazıları," VIII. Kazı Sonuçları Toplantısı, Vol. 2 (Ankara: Kültür Bakanlığı, 1986), 251-252; Ratté, Rojas, and Commito, "Notion Archaeological Survey 2017-2018," 5.

Section 1



Front View 1



Panoramic Elevation



Figure 90. Section, Front View, and Panoramic Elevation of the cavea. Drawings based on 3D point cloud done by the author.



Figure 91. Section of the theater in its current state based on 3D point cloud, modelled by the author.



Figure 92. Front view of the theater in its current state based on 3D point cloud modelled by the author.



Figure 93. Large lense photograph of the theater by the author.

Conservation State of the Theater





Figure 94. Theater current plan plan showing photograph locations. Photography by author.

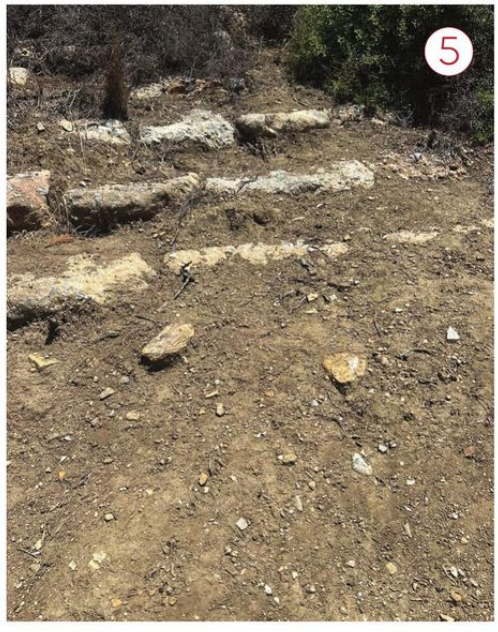






Figure 95. Conservation state of the theater. Photographs (1-8) by author.

04.

RISK ANALYSIS

4.1 Risks on the Urban Scale

The preservation of the archaeological heritage requires a clear and objective understanding of the decay mechanisms within the ancient city. The conservation approaches, particularly those addressing ruins, evaluate the site's conservation state based on a remarkable methodological distinction between the physical inherent weaknesses and the external threats it faces.[74] In order to evaluate these variables, the risk is mathematically and conceptually formulated through the equation:

Risk=Hazard x Vulnerability[75]

In this theoretical framework, the variables of the equation are not merely abstract mathematical concepts; they also serve as the precise categories used in the vulnerability assessments of the site. Besides, the equation can be related to the intrinsic and extrinsic factors of the ancient city of Notion.[76]

Therefore, it is necessary to establish a methodology for evaluating these intrinsic and extrinsic factors in the ancient site. However, the following approach will guide to define the vulnerabilities and intrinsic or extrinsic factors on the targeted area.

In the formula "Vulnerability" relates to "Intrinsic Factors" refers to how responsive a monument or a material is to physical damage. It does not point out a threat itself, but rather the passive condition of the structure, determined by the material type, construction technique, and its physical state, and physiological aging.[77] For instance, the porosity, surface roughness and mineral composition of the stone define its "bioreceptivity" the capacity of the substrate to host biological growth and colonisation. Therefore, conglomerate stone use in Notion's ancient theater and its dry-stone technique without mortar illustrates a category of intrinsic vulnerability.[78]

Conversely, "Hazard" refers to the active external forces with destructive potential, extrinsic factors that threaten the monument from the outside. However, wind, seismic activity, anthropogenic disturbances such as illegal excavations, the mechanical and chemical action of invasive root systems, and the lack of continuous maintenance all constitute extrinsic hazards.[79] In order to apply this framework to the vulnerability analysis of Notion, this chapter structures the analysis of intrinsic and extrinsic factors[80]. In order to apply this framework to the vulnerability analysis of Notion, this chapter structures the assessment across the broader urban scale and subsequently narrows the focus to the ancient theater, where the most severe vulnerabilities and decay mechanisms due to biological reasons within the city are observed.

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74. Giulia Caneva, Seyedehzohreh Hosseini, and Flavia Bartoli, "Risk, Hazard, and Vulnerability for Stone Biodeterioration Due to Higher Plants: The Methodological Proposal of a Multifactorial Index (RHV)," *Journal of Cultural Heritage 62* (2023): 217–229. See also Giulia Caneva, Maria Pia Nugari, and Ornella Salvadori, La biologia nel restauro (Firenze: Nardini Editore, 1994); and O. Guillitte, "Bioreceptivity: A New Concept for Building Ecology Studies," *Science of the Total Environment* 167 (1995): 215–220.
75. Caneva, Hosseini, and Bartoli, "Risk, Hazard, and Vulnerability," 217–229.; cf. Maria Adele Signorini, "L'*Indice di Pericolosità: un contributo al controllo della vegetazione infestante nelle aree monumentali*," *Informatore Botanico Italiano* 28 (1996): 7–14.
76. Caneva, Hosseini, and Bartoli, "Risk, Hazard, and Vulnerability," 217–229. ; Luigi Marino, *Il restauro archeologico* (Firenze: Alinea, 2013), 131. ; Tessa Matteini and Andrea Ugolini, *Il bisbiglio dei ricordi indefiniti: Progetto paesaggistico e conservazione attiva dei luoghi archeologici* (Padova: Il Poligrafo, 2023), 179. T
77. Marino, *Il restauro archeologico*, 53.
78. Ibid.; Guillitte, "Bioreceptivity," 215–220.
79. Signorini, "L'Indice di Pericolosità," 7–14; Marino, Il restauro archeologico, 97–100.
80. ICOMOS, Charter for the Protection and Management of the Archaeological Heritage (Lausanne: ICOMOS, 1990), Articles 4–6.

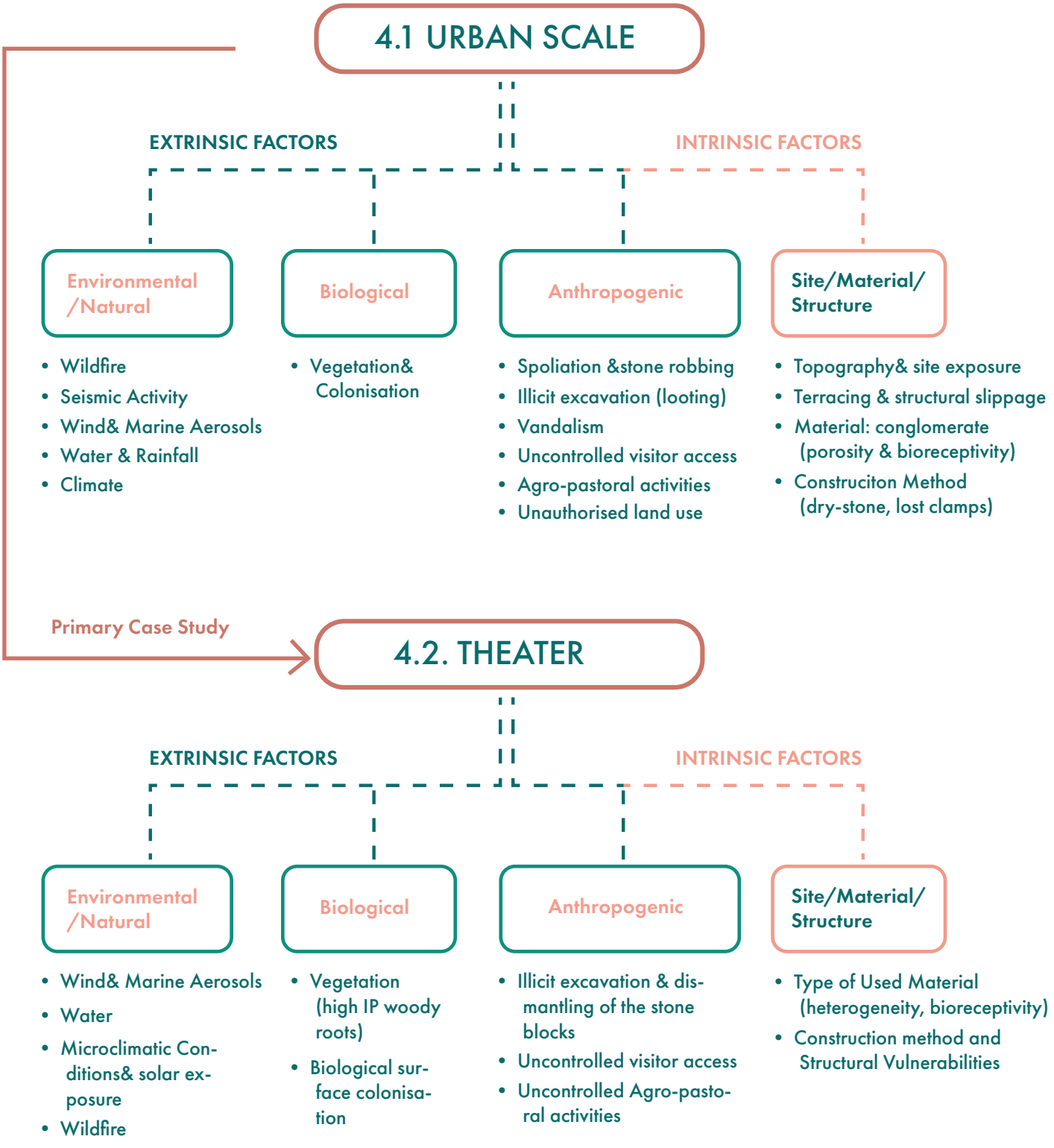

4.1 URBAN SCALE
EXTRINSIC FACTORS
INTRINSIC FACTORS
Environmental /Natural
Biological
Anthropogenic
Site/Material/ Structure
• Wildfire
• Seismic Activity
• Wind& Marine Aerosols
• Water & Rainfall
• Climate
• Vegetation& Colonisation
• Spoliation &stone robbing
• Illicit excavation (looting)
• Vandalism
• Uncontrolled visitor access
• Agro-pastoral activities
• Unauthorised land use
• Topography& site exposure
• Terracing & structural slippage
• Material: conglomerate (porosity & bioreceptivity)
• Construciton Method (dry-stone, lost clamps)
Primary Case Study
4.2. THEATER
EXTRINSIC FACTORS
INTRINSIC FACTORS
Environmental /Natural
Biological
Anthropogenic
Site/Material/ Structure
• Wind& Marine Aerosols
• Water
• Microclimatic Conditions& solar exposure
• Wildfire
• Vegetation (high IP woody roots)
• Biological surface colonisation
• Illicit excavation & dismantling of the stone blocks
• Uncontrolled visitor access
• Uncontrolled Agro-pastoral activities
• Type of Used Material (heterogeneity, bioreceptivity)
• Construction method and Structural Vulnerabilities



Figure 96. Chronological history diagram of the past wildfires in Ahmetbeyli Region. Diagram by the author.

4.1.1 Extrinsic Factors (Hazards)

A. Environmental and Geological Hazards

Wildfires

The ancient city of Notion occupies a landscape characterised by dense maquis vegetation and the dominant shrubland cover typical of its coastal terrain. The climate of this region creates conditions highly conducive to wildfire due to its hot summers. While the wildfires are quite common in the Mediterranean ecosystems; they have become increasingly frequent across the region in recent decades due to increasing summer temperatures, extended drought seasons, and the absence of active vegetation management. (Figure 96)

Wildfire has been a long-standing risk throughout the city's history with its dense vegetation occupation after the abandonment (Fig. 97). Archaeological excavations at Notion have revealed layers of ash and burnt mudbrick from as early as the Early Bronze Age, demonstrating that severe fires have been a recurrent destructive force causing the collapse of earlier settlement phases. Furthermore, the threat of wildfires at archaeological sites goes beyond just the burning of surface vegetation; it also acts as a severe extrinsic hazard that triggers rapid physical and chemical degradation. Forest fires cause extreme thermal shock that can crack stones and weaken their structural components. Because the main building materials used in the city are porous limestone and conglomerate, the intense heat causes these materials to calcine, resulting in cracks and leaving a crumbly residue that erodes easily.

This destruction was catastrophically demonstrated during the Great Notion and Claros Fire of July 8–9, 2007. The wildfire spread through the Notion and Claros, heavily damaging the ancient theater of Notion with its seating blocks and the rock-cut tombs. Significantly, extreme heat causes fractures and damage to architectural elements, including the destruction of architectural details.

The recent fires in the surrounding region highlight this ongoing threat. On August 2 2020, a severe wildfire started in the neighbouring Çile region and reached the Ahmetbeyli coastline due to strong winds. The fire destroyed the buffer zone, which has a dense forest around Notion's western headland, necessitating the emergency evacuation of nearby residential areas, and left the archaeological topography highly vulnerable. Similiarly, on June 29 2024, another fire started in Ahmetbeyli in the forested hills surrounding the site.



Figure 97. View of the site landscape illustrating its exposure to environmental risks. Photograph by the author.

However, it was controlled before reaching the Notion site itself. Since these modern fires did not cause the structural collapses of the monuments like the Theater on the ancient site, which had already been dislocated by root wedging and historical spoliation; increased severely the surface fragility of the remaining exposed. These recent fires worsen the long-term potential risk for the site. It is remarkable that the post-fire erosion is highly destructive to vegetation covered archaeological sites. When protective plants and roots are burned away, the unexcavated historical layers are left exposed to heavy rain and wind erosion.

On the site, where the protective soil overburden is already critically thin due to the steep topographic conditions of the promontory, post-fire erosion poses a long-term threat to both the visible ruins on the surface and the remains buried underground. A preventive strategy is required to address this severe extrinsic hazard. Rather than the complete eradication of vegetation, site management must focus on the selective clearance of highly flammable dry underbrush and the programmatic maintenance of the site's buffer zones, thereby preserving the symbiotic relationship between the ruins and their protective green canopy while minimizing fire risk.

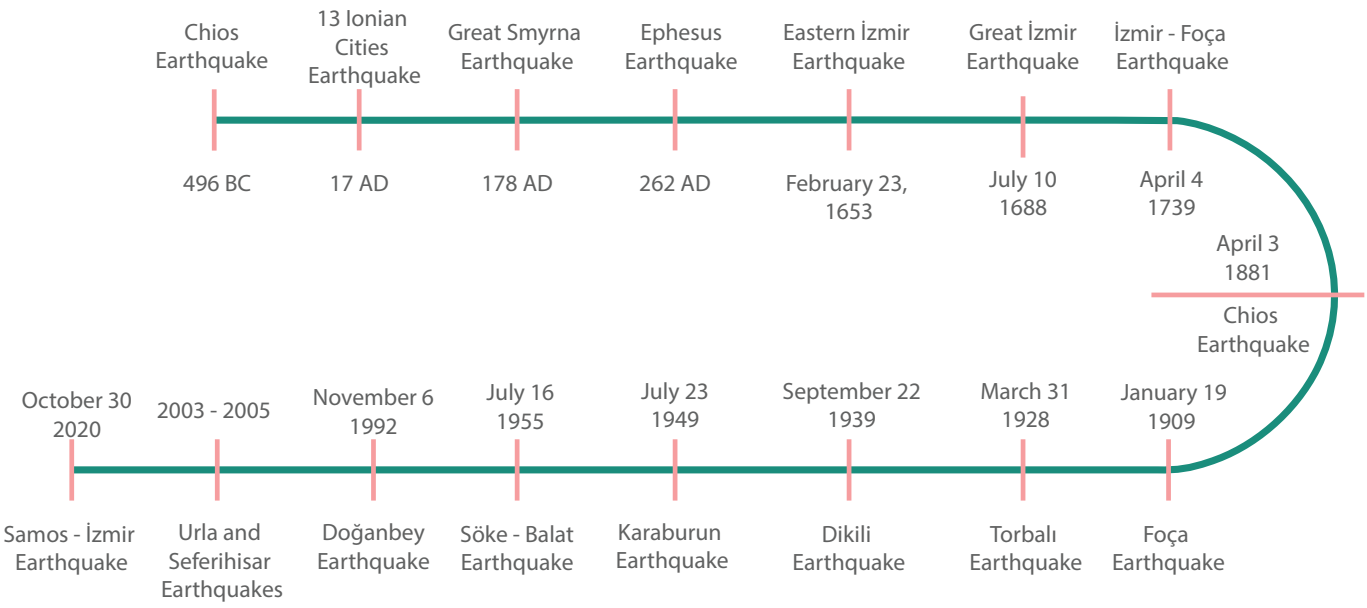


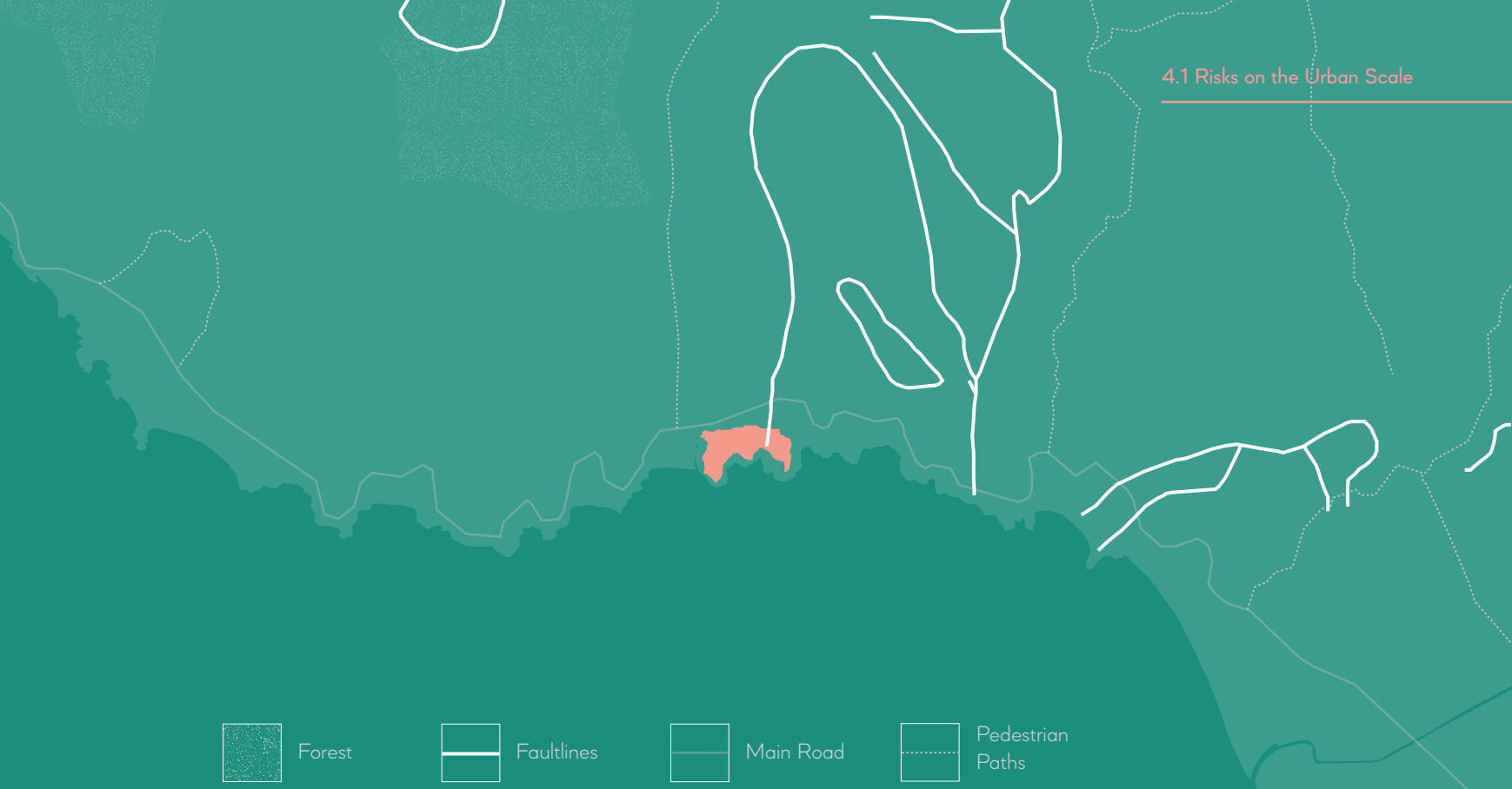
Figure 98. Timeline of major earthquakes and fires affecting the region. Diagram by the author..

Seismic Activities and Major Historic Earthquakes

The site is situated within one of the most seismically active zones (Fig. 98, 99), directly above the active Seferihisar-Tuzla and Cumaovasi fault zones. Throughout its history, the city has been affected drastically by these earthquakes. Especially, the most devastating earthquake in the 4th century AD caused the structural collapses in the city, therefore necessitating extensive repairs to the city's monumental buildings. Besides, in recent history, the October 2020 Izmir-Samos eartquake demonstrated that these seismic threat remains an ongoing hazard along this part of the Aegean coast.

On the urban scale of Notion, the seismic hazards remarkably dislocated the physical layout of Notion's monuments. Due to the construction methods of the monuments in Notion, which primarily used dry-stone masonry without mortar or mechanical fasteners, the structures became highly vulnerable to the ground motions. The stone of the monuments did not act as a unified structure; therefore, the stone blocks shift independently, leading to displacement and collapses.

The physical evidence of this urban-scale destruction is quite visible in two main areas in the ancient site. The fortification walls along a 3 km circuit have caused notable out-of-plane failures.



Therefore, multiple sections of the fortification walls were permanently displaced, and the components had been scattered around over the centuries due to tectonic effects.

Besides, the earthquake also caused severe displacement of the public monuments along the central ridge of the site. In the Bouleuterion, seismic effects displaced the heavy stone blocks and scattered architectural elements from their original positions. The ruined and fragmented state of the civic centre at present is directly linked to the consequences of these repeated historical earthquakes.

Figure 99. Map of the fault lines around Izmir in relation to Notion. Map by the author.

B. Biological Hazards

Vegetation

The ancient city is distinguished not only by its remains, but also by its variety of flora, which forms the character of historical sites and ecological significance. The site hosts a diverse range of vegetation across the landscape. Regarding this vegetation cover, it is important to have a balanced strategy regarding the removal of the vegetation. Therefore, the primary objective is understanding the relationship between vegetation and the ruins, ensuring the coexistence.

However, the presence of plant species that grew alongside the stone structures cannot be ignored. Specific growth habits and the root morphologies of the plants pose risks to the physical integrity of the remains. The management of these threats requires a case-by-case evaluation utilising the Signorini method and the Hazard Index (IP) to assess species-specific risks based on their root morphology, growth habit, invasiveness, and observed impact on the ruin itself. Within this framework, it is crucial to define the plant species for assessing whether their IP value exceeds 7, which are classified as posing severe risks to the stone structures. Even though the ancient city's monuments have many existing species with high hazard values, the theater has the most widespread vegetations and colonisation on its vulnerable conglomerate seatings and the dry-stone sections of the fortification walls. The fortification walls face the external threat posed by dense vegetation growth. It was mostly built by the dry stone technique, thereby the invasive root systems of the plants penetrate their structural joints.

Over time, growing roots wedge between the stones have impacts on the stone's structural integrity; resulting in the dislodgement of the blocks and even collapses. Additionally, dense vegetation promotes moisture retention on the wall surfaces and within the core fill, preventing the stones from drying out adequately (Fig. 100,101).

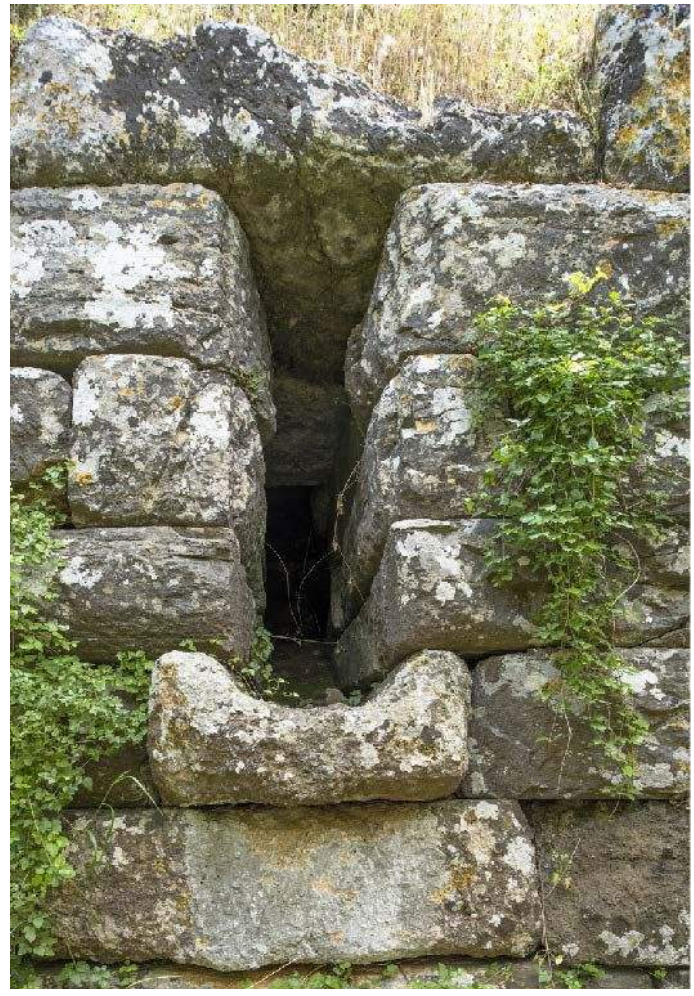


Figure 100. Vegetation growing on and through the fortification wall. Source: Rojas and Marko (2019), 23.



Figure 101. Plant growth disrupting masonry. Source: Rojas and Marko (2019).

These conditions accelerate the decay of the stones in the walls. Consequently, it is important to note that the most aggressive extrinsic factors threaten the structural integrity of the fortifications. Therefore, the identification and selective management of these high-risk species are among the most important aspects of Notion's conservation strategy. Accordingly, the implementation of the intervention should involve targeted, controlled removal of high IP trees and shrubs, along with controlled maintenance.

C. Anthropogenic Hazards



Figure 102. Spolia in later walls at Notion. Source: Rojas and Marko (2019), 27.

Stone Robbing and Spoliation

The removal of ancient building materials for reuse has been a major, ongoing hazard to the conservation of Notion's primary structures from late antiquity to the present. At Notion, the targeted materials were finished, transportable blocks of marble and limestone, leaving behind structural cores and rubble fills for use in constructing other buildings for themselves. This reuse of ancient stones has been documented especially throughout the Byzantine, Ottoman, and early modern periods due to the absence of any site access control. After the city was abandoned, the locals dismantled the stone (Fig. 102) remains to reuse them in new constructions (spolia). Within the site, the most prominent evidence of material loss and spoliation is observed in the fortification walls. The western part of the walls, situated on the steepest and most unstable promontory, suffered from a combination of steep terrain and seismic activity, which probably caused the walls to start to fail relatively soon after their construction. During these repairs, massive and repurposed ancient marble blocks (*spolia*) dismantled from the other buildings were utilised in the fortification wall reinforcement. Unlike the original dry stone masonry technique, these reused blocks were bound together with hard white mortar, illustrating a historical evolution in the reuse of building materials within the city.[81]

81. Schuchhardt, "Kolophon, Notion und Klaros," 399–400; Christopher Ratté vd., "Notion Archaeological Survey, 2014-2015," 622.



Figure 103. The Byzantine tower at Notion. Source: Demangel and Laumonier (1923), fig. 6.

The city's central public spaces also suffered from the dismantling of the construction components. The specifically targeted valuable architectural elements, including columns and superstructure blocks around the Bouleuterion and Agora, were systematically targeted. However, these stones were carried off-site to be reused in the modern neighbouring town of Gavurköy to build local houses. Moreover, the ancient city suffered from spoliation caused by early 20th century excavation campaigns. The most striking example of internal spoliation appears at the Temple of Athena. During the Late Antique or Byzantine period, the walls of the temple was dismantled, and its massive architectural blocks were reused to construct a Byzantine defensive wall, called as Byzantine tower, located immediately southwest of the temple. However, during the 1921 excavations, by French archaeologists Robert. Demangel and A. Laumonier had to completely dismantle the Byzantine tower in order to recover and document the Temple of Athena (Fig. 103).[82] However, this intervention had disrupted the historical stratigraphy of the temple and erased the its Byzantine phase. Additionally, during the excavation the marble blocks were left scattered around the temple. At present, this threat still continues in the forms of undocumented displacement of the archaeological components. The physical isolation of the site makes it defenseless target for the antiquities smugglers.

82. Demangel and Laumonier, "Fouilles de Notion (1921)," 363. Christopher Ratté vd., "Notion Archaeological Survey 2017-2018," Araştırma Sonuçları Toplantısı 36 (2019): 3.

Illicit Excavations and Looting



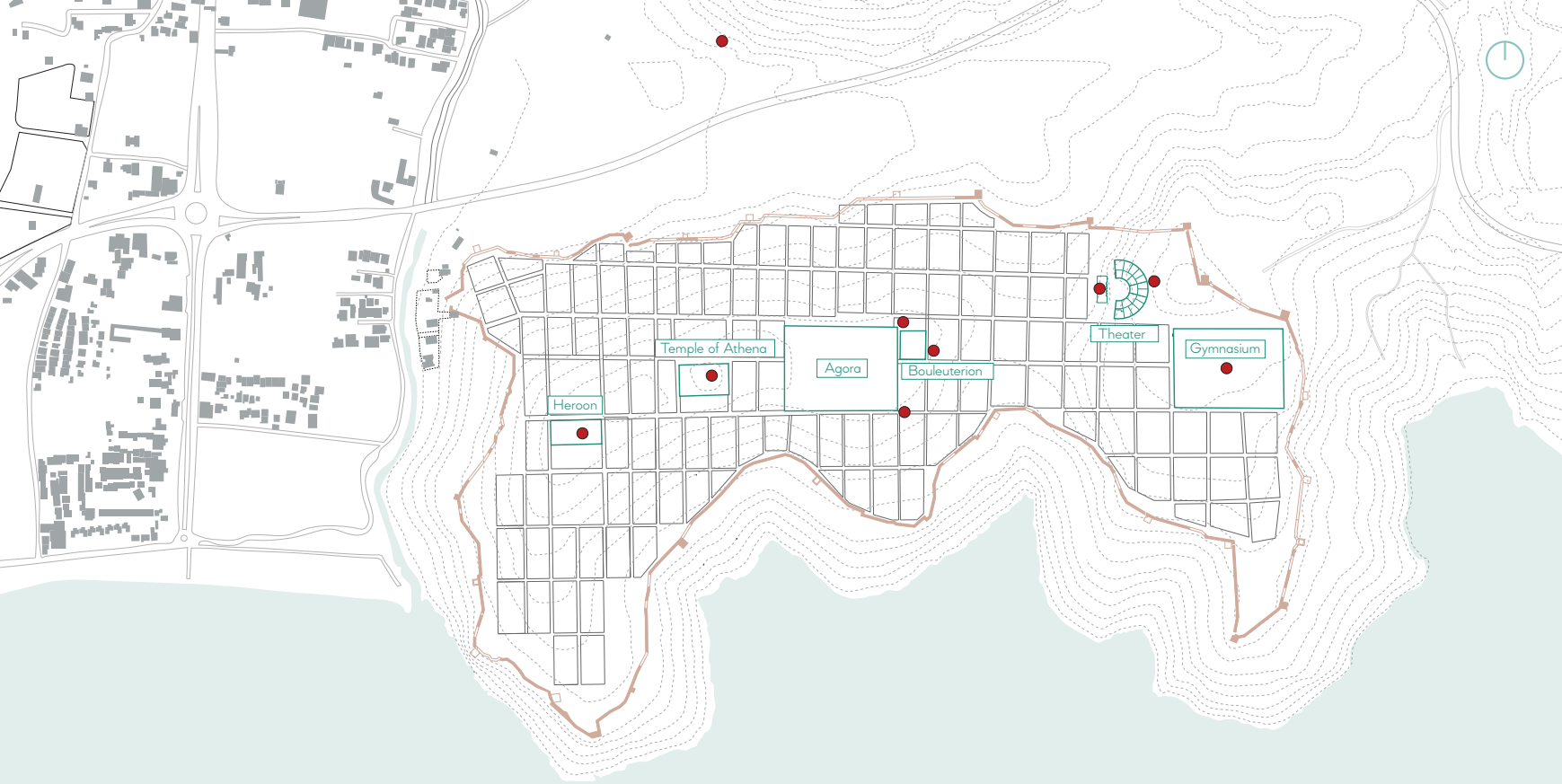
Figure 104. Large dolium exposed by illegal excavators north of the Agora. Source: Ratté (2022).



Figure 105. Recent illicit excavation trench in the Gymnasium. Source: Ratté (2022).

The documented archaeological significance, with regard to the recovered inscriptions, terracotta figurines, coins, architectural sculpture, and ceramic assemblages across multiple seasons of controlled excavation, makes the site a prime target for illegal excavations throughout its history. Unauthorised excavation represents a catastrophic threat to archaeological integrity as it disrupts their original context, thereby erasing the crucial spatial and relational data from the site for archaeological interpretations. Historical spoliation primarily targeted the visible civic buildings and fortification walls for the architectural reuse of their materials. During the field surveys across the site, the team has documented the locations of these illegal excavations and trenches, including destroyed artefacts, breaks in ceramics, and the foundations of the buildings. The structural and mechanical decay of the remains violently alters their physical condition (Fig. 104) and also creates intrinsic vulnerabilities in the ancient structures within their material integrity.

The documented cases are situated in civic monuments as Gymnasium (Fig. 105, 106), subterranean water infrastructures within the site, the necropolis and quarries in the ancient city. Especially, the deep robber trenches have been dug into the civic core of the city in Bouleuterion. Notably, a massive trench measuring 3 m by 1.5 m was illegally excavated directly into the auditorium of the Bouleuterion during the winter season of 2013-2014, besides several deep trenches have been found in the terrace fills on the northern part of the Agora. Regarding its vulnerability impact on the remains, the deep trenches severely compromise the structural situation of the retaining walls and earthen foundational cores, such as Bouleuterion's rammed-earth core. Furthermore, the pits also accumulate the rainwater, causing the internal pooling that creates the collapses within the adjacent stone walls.



The unauthoritized excavations also appeared out of the fortification walls of the site. In May 2025, illicit excavators used dynamite to blast rock quarries and systematically dug the destructive pits in the northern Necropolis to dismantle the rock-cut tombs. Regarding the vulnerabilities of impact by these explosives created irreversible fractures in the local bedrock. This severe mechanical shock shatters the geological integrity of the promontory and accelerates the natural erosion of the cliffs and destabilises the topographical foundation upon which the city's eastern monuments rest.

Unfortunately, it is notable that the impacts of these activities on the remains and topography cannot be recovered through archaeological methods. The physical voids, fragmented drainage elements, and the structural weaknesses left behind by these illegal actions drastically complicate the future conservation efforts.

Figure 106. Map of illicit excavation locations at Notion. Map by author, based on Ratté, Rojas, and Commito (2015), figure 11.

Vandalism

The absence of physical barriers, interpretive signage and uncontrolled site access leaves the archaeological site entirely open to external risks. Although the site management efforts initiated in 2023 have enclosed the northern part of the site, the western and southwestern borders are still unfenced. This partial isolation has caused the anthropogenic degradation, including vandalism and unintended damage.

- **Deliberate Vandalism**

The intentional damage at the site includes the graffiti painted directly onto the ancient stone surfaces, the dumping of garbage such as plastic and glass materials within the ruin fabric, and the informal rearrangements of the site's topography. Besides, it is observed that visitors are building campfires (Fig. 107, 108) using displaced ancient building components. Additionally, severe architectural sabotage has occurred along the western side of the city. Recently, stone elements in the Temple of Athena and Heroon have been removed and dismantled from their vulnerable exposed bases. Although the actions, such as stone displacement and surface scratching, are particularly destructive for the softer stone elements constitute a progressive degradation of the site's legibility. This is destructive to the structural integrity of the fragile remains and the evidential records of the ancient craft and use.

- **Unintentional Vandalism**

An underestimated threat of the anthropogenic hazard posed by physical impacts has been caused by unregulated group visits and visitor traffic. The site currently receives solo hikers, casual visitors and large tour groups. The absence of a defined visitor circuit or marked trails to guide them, visitors often step right onto the fragile ruins, such as the crests of the Hellenistic city walls, the foundations of temples, loose stones in the Agora and the theater, and paint the ancient stones by the synthetic materials (Fig. 109).

The concentrated mechanical loading on these remaining surfaces creates structural stresses and risks, regardless of whether they have structural integrity problems. For instance, the tourist climbing to the ancient fortification walls directly threatens the unmortared masonry regarding their stability. Proportionally to the visitor numbers and their frequency creates greater risks for the vulnerable ruins without path guidance or regulated physical interaction.



Figure 107. Evidence of uncontrolled reuse of ancient stones. Source: User-contributed photograph, Google Maps, "Notion Ancient City," accessed May 3, 2026.



Figure 108. Evidence of uncontrolled reuse of ancient stones. Source: User-contributed photograph, Google Maps, "Notion Ancient City," accessed May 3, 2026.

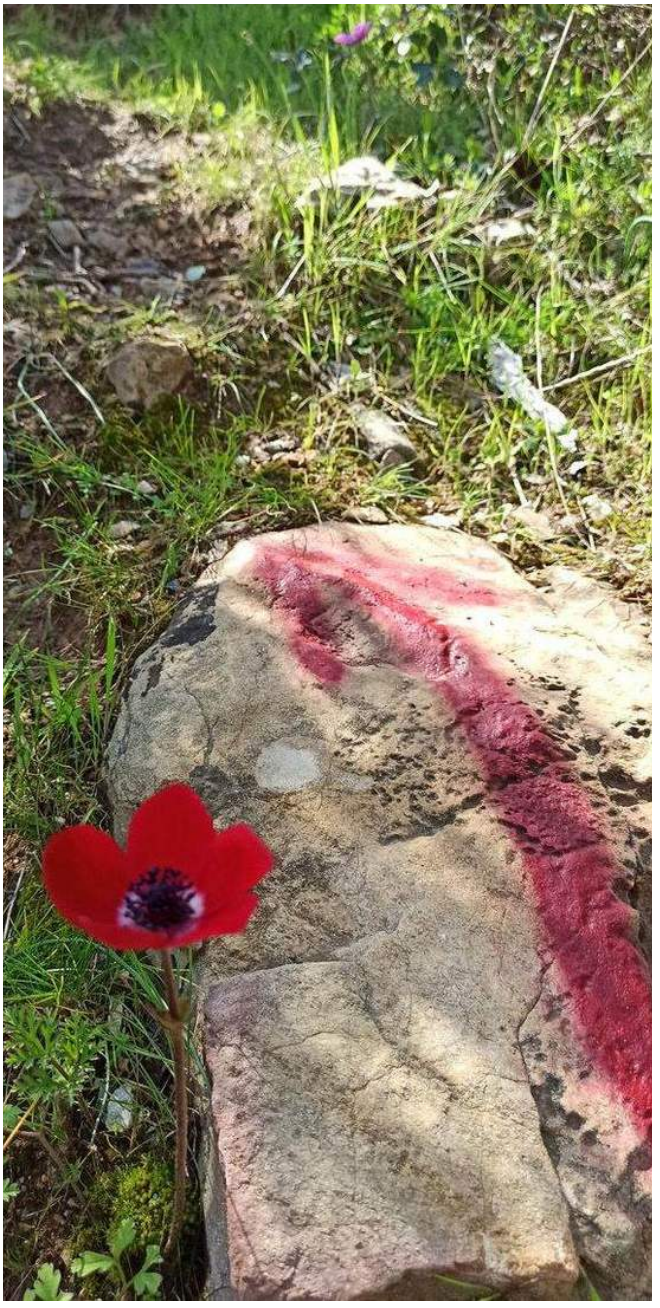
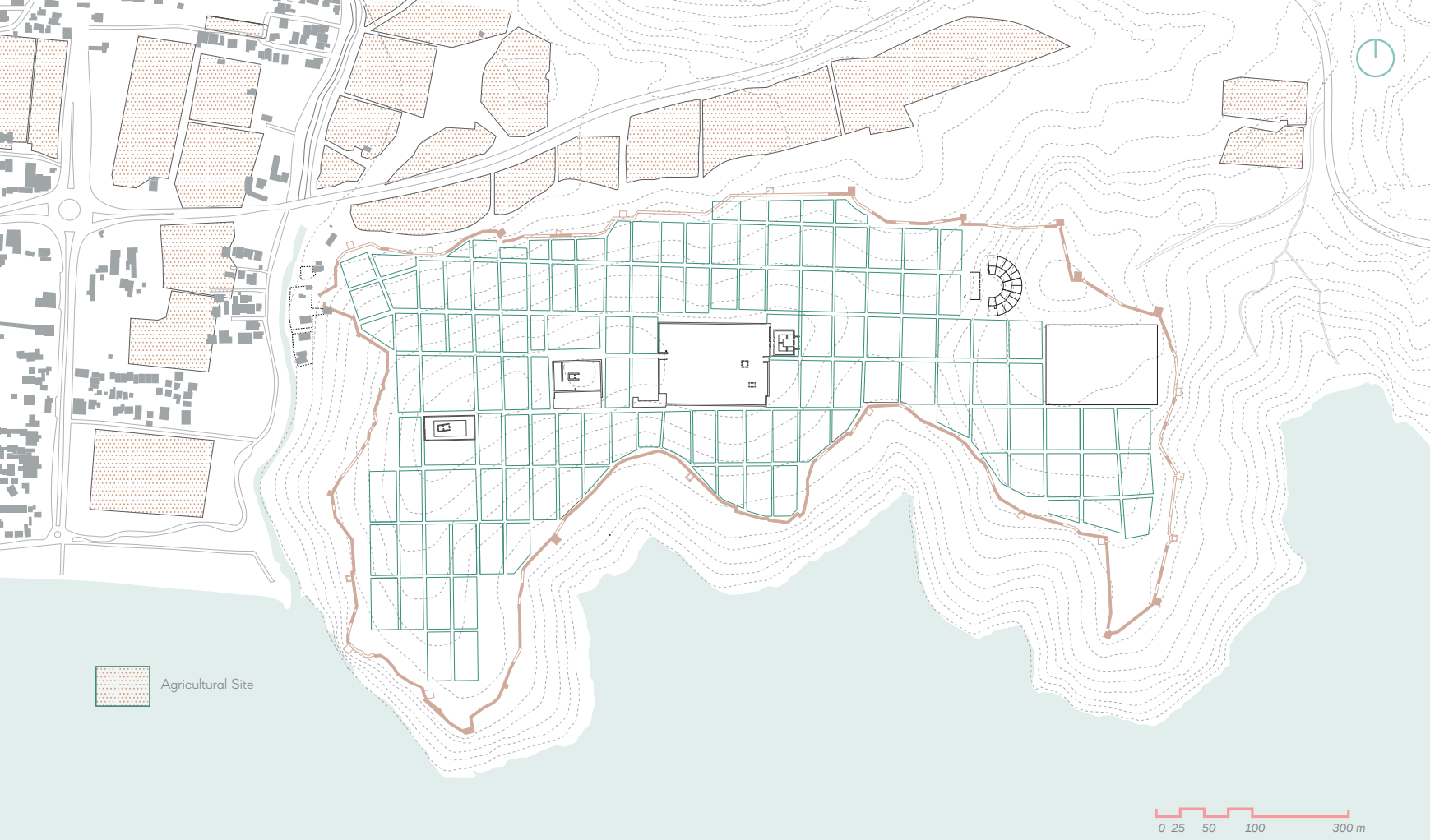


Figure 109. Evidence of uncontrolled reuse of ancient stones. Source: User-contributed photograph, Google Maps, "Notion Ancient City," accessed May 3, 2026.



Uncontrolled Agro-pastoral Activities

The site is situated within an active rural landscape where agricultural and pastoral activities have been continuing since antiquity. Since the site lacks comprehensive physical boundaries, local shepherds have been utilising the archaeological terrain for grazing. While this pastoral activity contributes to the site's historical and rural authenticity, the unrestricted access of herds causes specific extrinsic hazards to the monuments of the ancient site. However, the repeated passage of livestock has generated fixed routes along the site, with a naturally compacted soil base. The continuous movement of the flocks also poses a mechanical threat to the monuments, particularly to the fragile masonry, and risks dislodging already unstable blocks. In addition to the pastoral activities, the site faces significant threats from the adjacent agricultural cultivation. The field mapping demonstrates that the agricultural activities extend beyond the fortification walls; these cultivated parcels likely cover the unexcavated subsurface archaeological layers (Fig. 111). The agricultural vehicles have been utilised in these fields, creating threats to these unexcavated layers.

Significantly, the proposed intervention approach for this site does not seek the eradication of the agro-pastoral activities. A complete removal of the naturally and historically developed local activities is not suggested; however, such eradication could cause the sterilisation of the site's ecological and historical identity. Instead, the objective is the systematic regulation of the agricultural fields outside the fortification walls, given that they likely contain archaeological stratigraphy beneath them. Therefore, the agricultural and pastoral activities can be maintained outside the ancient site boundaries, preserving local livelihoods without harming the ruins and archaeological remains. The shift in the location of activities reduces risks while preserving the living landscape of Notion.

Figure 110. Map of agricultural farms within the site. Map by the author.



Figure 111. Agricultural land located on the outside and adjacent of the fortification walls the archaeological area. Photograph by the author.



Figure 112. Unauthorised residential buildings constructed on the fortification wall remains. Photograph by the author.

Unauthorised Land Use and Administrative Inadequacy

The governance framework of the Notion site has been struggling to prevent misuse of unauthorised land use. This administrative inadequacy constitutes a significant extrinsic hazard, as evidenced by both the physical damage to the site and its ongoing legal vulnerabilities.

The field surveys revealed that the modern residential structures have been situated directly on and adjacent to the Hellenistic fortification walls, with their foundations on the archaeological strata. A residential house near the city's harbour gate (Fig. 112) has its foundation directly on the fortification wall; however, this demonstrates the impacts of uncontrolled use of the site due to a lack of authorisation in the ancient city.

Remarkably, the modern vehicular road was constructed directly on the archaeologically sensitive zones, interrupting the spatial connection between Notion ancient city and its necropolis. The destruction caused by the road construction was documented and formally reported by Erol Atalay. Before the road construction, Atalay had explicitly warned that the planned route of the road construction would inevitably damage



Figure 113. Agripastoral activity in the site. Photograph by the author.

the ancient remains, during his 1985 excavation campaigns. Despite these warnings, the construction of the road proceeded, thereby the numerous unexcavated remains as Roman imperial architectural fragments along this road resulted in irreversible material loss, damages.

These events reflect that the site lacks the administrative control regarding its archaeological risk assessment. Besides, agripastoral activities also represent an ongoing and largely unregulated presence within the site boundaries. During the site visit, the grazing across the archaeological zone by the locals was observed, where animal movement and trampling cause direct physical damage to exposed structural remains and disturb the surface deposits (Fig. 113). The lackness of the comprehensive legal designation on the archaeologically sensitive spaces and ancient city can be categorized as a extrinsic risk factor for the ancient city. For mitigating these risks, it is crucial to coordinate the administrative and legislative action for aligning the site's historical significance.

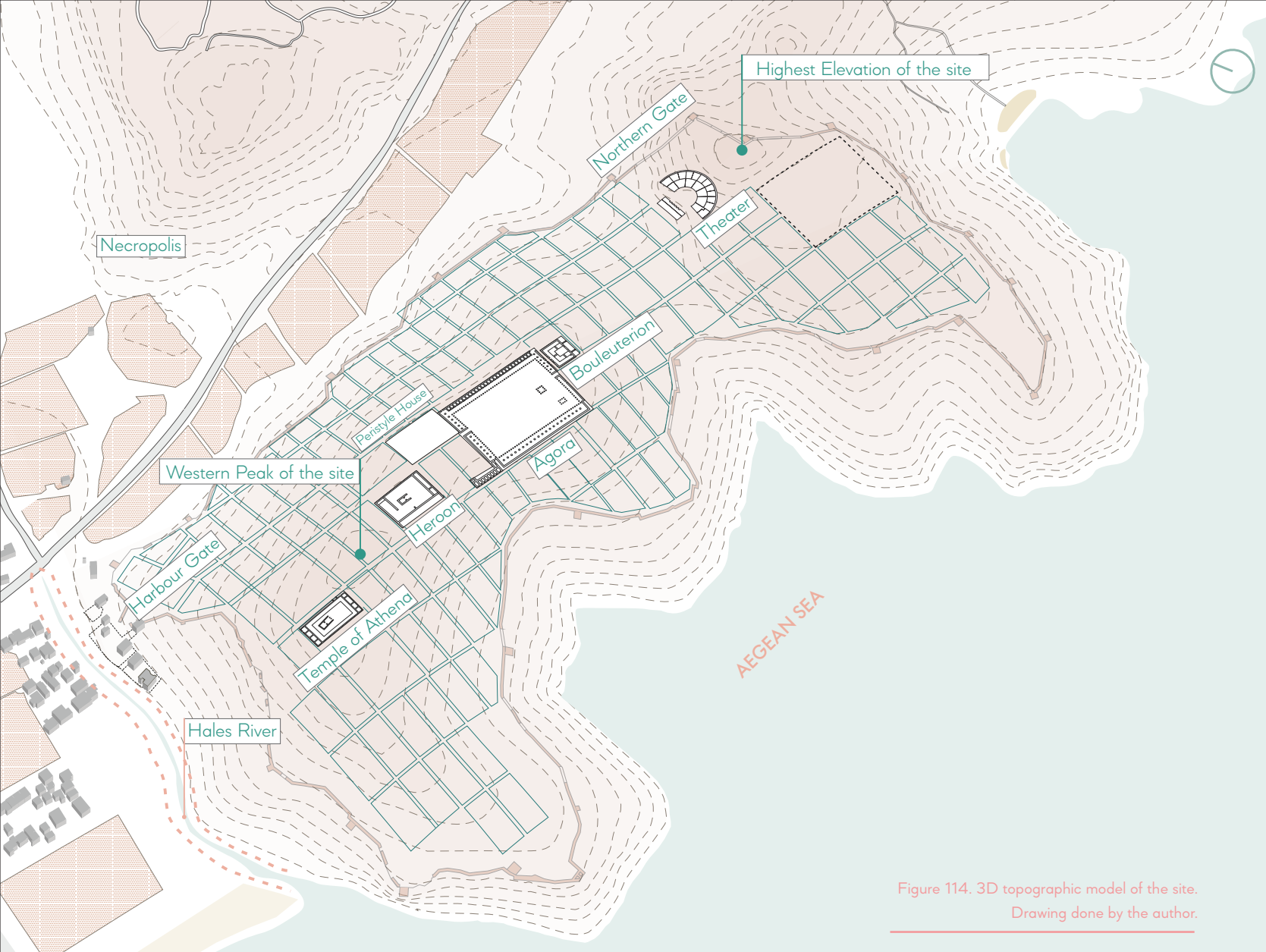


Figure 114. 3D topographic model of the site.
Drawing done by the author.

4.1.2 Intrinsic Factors (Vulnerabilities)

Topography and Site Exposure

Notion's steep and rocky topography around its two promontories along the Aegean Sea (Fig. 114) creates its intrinsic physical vulnerabilities. The promontories steeply rising from the coastline is exposed directly to the prevailing western and northernwest winds from the Aegean basin. This topographic exposure, which determined its maritime prominence in its history, simultaneously creates impacts on the architectural remains. While this open-air remains constructed mainly by marble and the conglomerate stones has been exposed to the aeolian winds, the steep topography of the city also accelerates the displacement of the remains. The construction materials of the ancient city, deposits the saline contaminants into the highly porous conglomerate and limestone fabric, and initiates progressively to the decays on the stone surfaces. Besides, the steep terrain causes the high velocity water run-off, effecting on the remaining surfaces as erosion during the rainfalls. Furthermore, the ruins on the steep terrain have a tendency to tilt outward and scatter down the hillsides by the gravity effect.



Figure 115. Coastal view of the promontory. Photo by author.

A further consequence of this topographic configuration is the minimal depth of the protective soil layer. Due to the wind and rain which are considered as extrinsic factors, erode through the upper to the lower parts of the site, the protective earth on the ancient ruins is not enough to prevent the wash-down effect of the rain. This condition is evident by the presence of at least 46 exposed ancient doorways (Fig. 115) still visible at the current ground surface, which has not been covered by enough sediment collected. Therefore, it is notable that wind and rain effects have been accelerated by the topography, resulting in the erosion of the remaining surfaces. (Fig. 116)

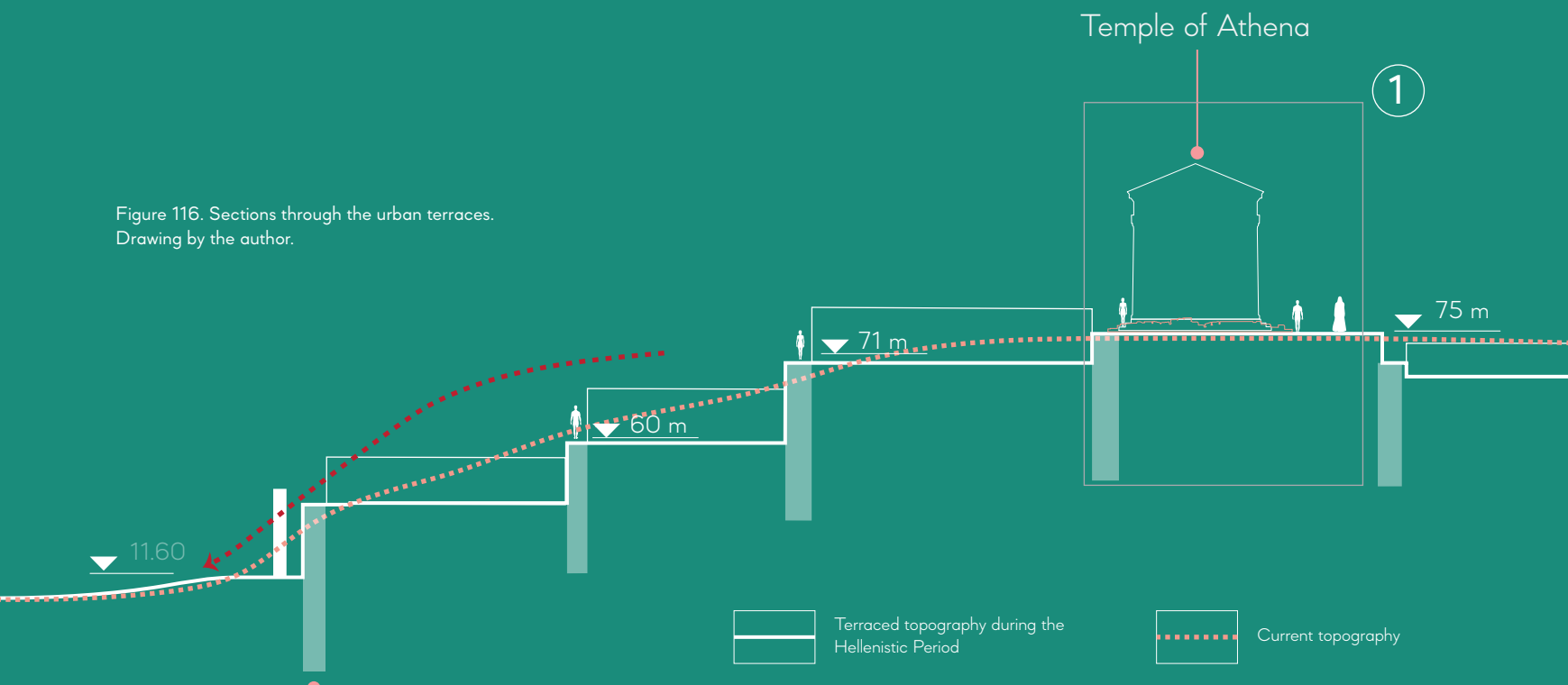


Figure 116. Sections through the urban terraces. Drawing by the author.

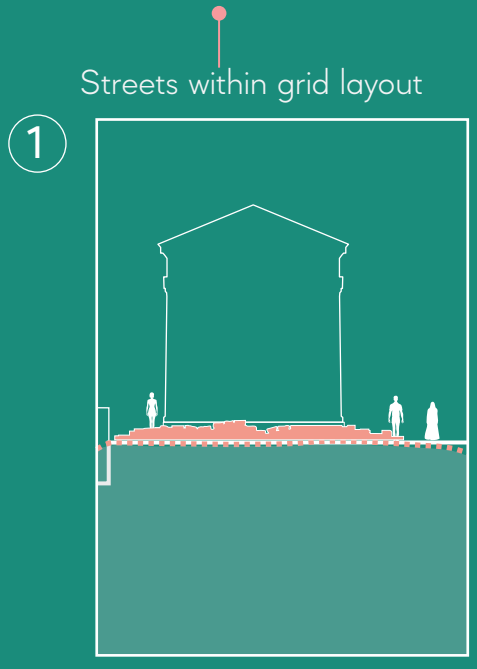
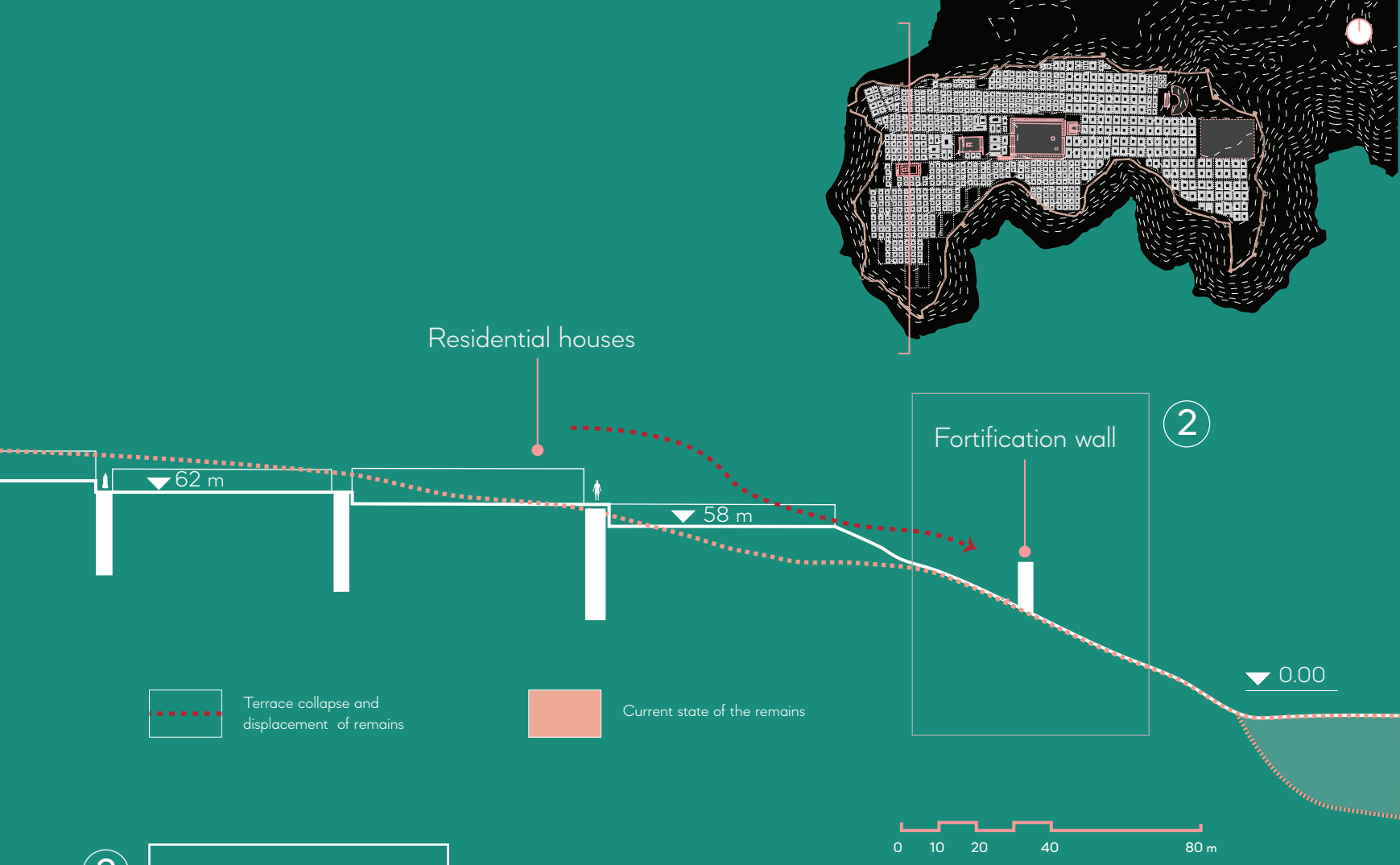


Figure 117. Comparison of the reconstructed facade of Temple of Athena and its current state. Drawing by the author.

Terracing and Structural Slippage

The urban layout of Notion, defined in the Hellenistic period, includes artificial terracing to deal with the site's steep coastal topography. While the Hellenistic grid plan became its characteristic, this infrastructure creates intrinsic vulnerabilities. The structural integrity of the mortar-free, dry-stone retaining walls and the buildings constructed upon them was mutually dependent. The retaining walls contained the fill on which buildings rested, while the mass of the buildings provided lateral resistance. (Fig. 119)

Therefore, over the post-antique period, the aging of these structures, combined with downward shear forces due to gravity and surface slides, has led to the progressive failure of this interdependent system. Since the retaining walls collapsed or eroded throughout the centuries, the terraced landscape transformed into a continuous slope, triggering widespread terrace collapse and scattering.



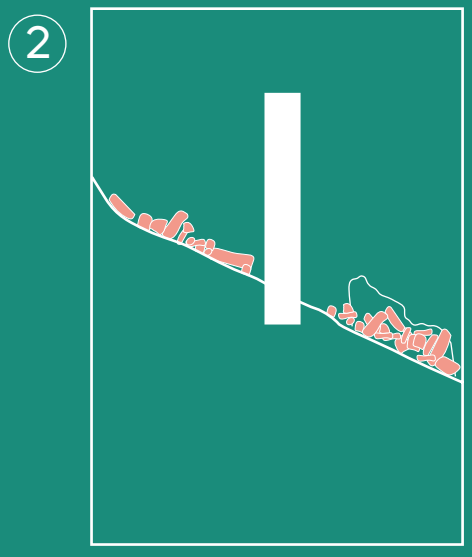


Figure 118. Diagram of the retaining walls. Drawing by the author.

The consequences of this failure for the ruins could be explained by two aspects. Primarily, the loss of founding platforms has subjected the upper parts of the buildings to severe structural sliding, resulting in progressive tilting, displacement, and a collapse of architectural elements.

However, this ongoing process significantly reduces the structural coherence and spatial legibility of the standing remains. Secondly, the downslope movement of the terrace fill scattered the associated heritage of the remains, irreversibly displacing artefacts from their original context and harming the site's stratigraphic integrity. Significantly, the identification of collapse zones and the active conservation of structural remains of the monuments in the city is a critical management priority in order to diminish forthcoming dislocation risks and preserve the site's archaeological history.



Figure 119. View of sorted stones in the site. Photograph by the author.

Type of Used Material

The existing quarries in the site and surrounding regions provide reasonable material for building construction. Construction materials used across the site include local white and blue-grey limestone, marble (predominantly for architectural ornament, column drums, and inscribed monuments), schist, calcareous sandstone, and conglomerate (Fig. 119). Notably, the distribution of these materials is not uniform; for instance, the construction of the fortification walls' local materials is most clearly expressed, with an estimated twenty to thirty percent of its fabric composed of conglomerate stone, particularly in lower courses and at locations where the circuit follows the natural rock substrate most closely.

Conglomerate, a sedimentary rock composed of rounded clasts bound by a calcareous or siliceous matrix, causes many intrinsic vulnerabilities. Its heterogeneous structure makes it highly susceptible to differential erosion. Furthermore, the high porosity and surface roughness of the conglomerate suggest a high capacity of bioreceptivity and moisture retention, causing the stone to act like a sponge even during the dry Mediterranean summers. Under the conditions of repeated wet-dry cycling and salt crystallization induced by wind-driven marine aerosols, this heterogeneity of the material accelerates surface disaggregation more rapidly than occurs in the more homogeneous limestones employed in the superstructure. The consequent fragility of conglomerate courses, some of which serve as load-bearing members in still surviving wall sections, represents an intrinsic structural weakness. This condition risks the long-term durability of the remains regarding its structural stability, especially in the lower parts of the fortification walls.

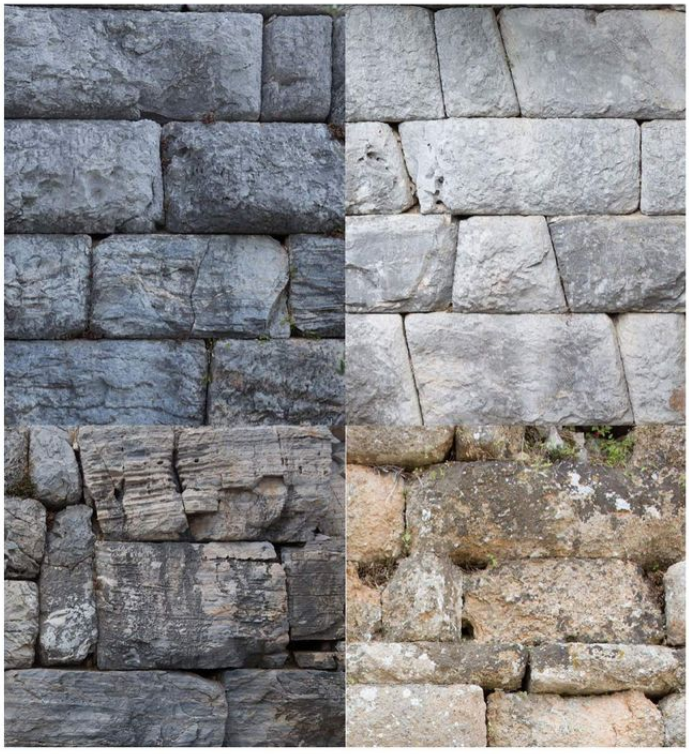


Figure 120. Masonry close-up from the fortification walls. Source: Rojas and Marko (2019), 8.



Figure 121. Masonry close-up from the fortification walls. Source: Rojas and Marko (2019), 7.

Construction Method and Structural Vulnerabilities

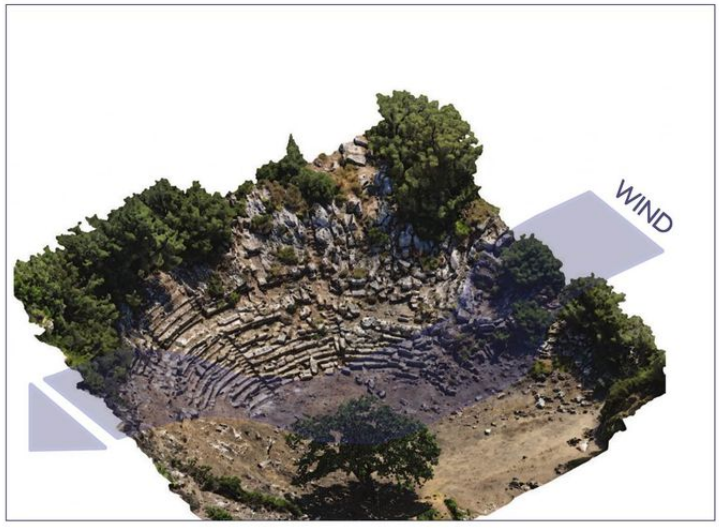
The construction methods of the monumental structures in Notion are primarily based on the mortar-free, dry-stone (*opus quadratum*) technique, in which individual stone blocks are assembled without mortar (Fig. 120, 121). Thereby the structural integrity of fortification walls was provided only by the mechanical interlocking of the contact surfaces and the gravitational load of the superimposed blocks. In contrast, monumental structures such as the ancient theater, the Bouleuterion, and the better-preserved sections of the fortification walls employed a much more sophisticated system consisting of iron clamps and dowels sealed in molten lead.

Furthermore, the malleable lead casings originally acted as crucial *seismic isolators,* offering the micro-elasticity needed to absorb dynamic stresses. However, the current physical state of the ruins demonstrates severe intrinsic vulnerabilities to dynamic loadings. When the systematic historical looting (spoliation) of the metal fasteners is combined with the aging of the structures, the masonry system has unfortunately completely lost its original capacity to redistribute internal stresses generated by movements or seismic activities.

Under contemporary seismic conditions, which are of great importance given the city's tectonic location, this compromised dry-stone system performs quite poorly. The reason for this is, the absence of a continuous binding material (lead/clamp) to provide elasticity causes the displacement of any single block to be transmitted directly to adjacent stones. This situation accelerates sudden movements that lead to the out-of-plane collapse of the structure. Indeed, the collapse and scattering patterns observed throughout the ancient site perfectly align with this structural decay mechanism.

In addition to all this, the ongoing differential erosion on the contact surfaces of the porous calcareous and conglomerate stones narrows the effective bearing area between the blocks over time. As the edges of the stones crumble and deteriorate, the critical frictional resistance that keeps the system standing also gradually disappears. Consequently, this construction system, which was once tightly interlocked, today transformed into an assemblage of increasingly loosely fitting elements; thereby, it has progressively and irreversibly lost safety against structural collapse.

4.2 Risks in the Theater



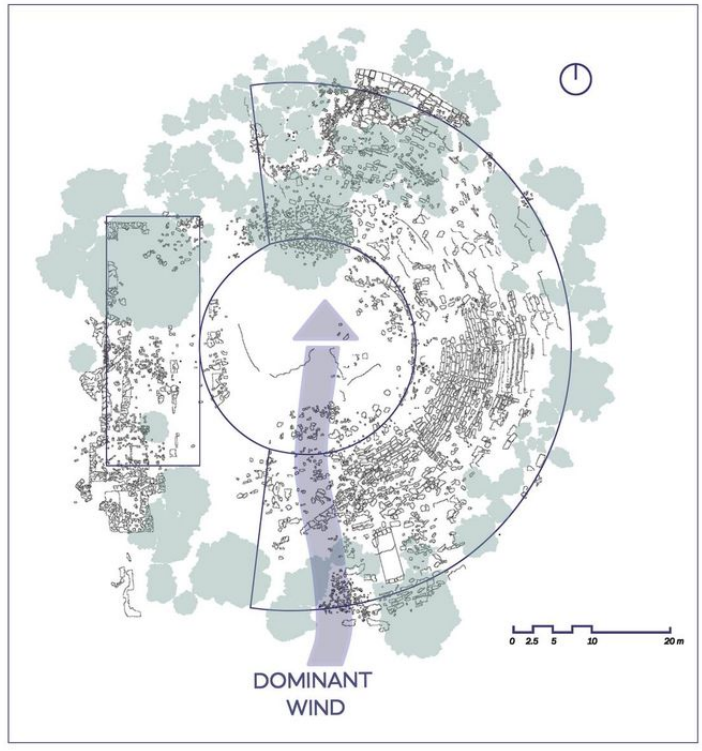


Figure 122. Dominant wind direction from the Aegean Sea on pointcloud model (left) andplan of theater (right). Diagram by the author.

4.2.1 Extrinsic Factors (Hazards)

A. Environmental and Natural Hazards

Wind and Marine Aerosols

The ancient theater of Notion occupies a position on the western slope of the eastern hill, directly exposed to the prevailing westerly and north-westerly winds of the Aegean Sea (Fig.122). The theater is facing the hillside above and the sea view beyond with its exposed surfaces of the cavea seating blocks and the partially surviving foundation of the stage building. The impacts of wind on the theater directly onto the stone surfaces of the theater, accelerating the decay mechanisms when it meets with the aerosol particles carried from the sea. The wind exposure is extremely destructive due to the specific material used in the theater. The seating area of the theater was extensively constructed by a conglomerate, which is a fragile stone consisting of pebbles and softer binding material.

Under the effects of wind, this softer binder erodes easily, causing the pebbles to fall out or loosen. This phase leaves cavities and creates a very critical structural vulnerability. As the stones' surfaces erode and crumble, the blocks lose their tight fit. The original metal clamps that connected the blocks were looted long ago; as a result, the entire dry-stone seating area is quite weak.

The stone cavities could serve as natural traps for moisture, windblown soil, and seeds. Thereby, this physical wind effect transforms into a biological hazard, accelerating the plant and biological colonisation across the seating area, which further weakens the ruins.



Figure 123. Visitors during rain in Notion. Photography by the author.

Water

The current geometry and topography of the site (Fig. 123) and the theater create a severe inherent vulnerability to water. Essentially, the entire cavea acts as a massive funnel, collecting rainwater from the upper slopes and channeling it directly down toward the orchestra. In antiquity, this heavy water flow was safely managed by an efficient drainage system integrated into the floors and sub-pavements. However, the complete loss of this infrastructure over the centuries means that rainwater now flows uncontrollably across the theater remains. Consequently, as surface water rushes down the stepped profile of the seating tiers, it creates linear erosion channels, mechanically washing away the weakened conglomerate matrix along its path. Beyond this direct mechanical erosion, the most destructive impact of water is moisture infiltration. The water penetration on the unmortared dry-stone joints of the seating tiers triggers a chain of secondary decay mechanisms.

Given the moderate Aegean coastal climate, freeze-thaw action is not a significant factor here; instead, the trapped moisture drives severe wet-dry cycles and accelerates the generation of some cavities within the porous stone. Furthermore, this prolonged moisture retention drastically increases the stone's bioreceptivity. The damp joints provide an ideal environment for the germination of vascular plants and promote the aggressive development of moss, algae, and lichen colonies across the surfaces. It is significant that the carried soil and organic debris from the upper slopes down into the lower parts in the cavea zone accelerates the decay mechanisms. Besides, the continuous dislocation blocks any remaining natural drainage from its original layout, creating a water accumulation in the theater's cavea and orchestra with its changed topographical condition. This constant dampness not only accelerates biochemical decay; also severely threatens the structural stability of the cavea.



Figure 124. Sun exposure visible in the area, red rectangle marking the shaded area. Photograph by the author.

Microclimatic Conditions and Solar Exposure

The east-west orientation of the theater caused remarkable differences in solar exposure across the seating area. The southern part of the cavea receives significantly less direct sunlight throughout the day and is heavily shaded by the hillside (Fig. 125). This persistent shade creates a damp microclimate characterized by lower temperatures and reduced evaporation rates, which significantly promotes intense bio-colonization. The resulting prolonged surface moisture increases the bioreceptivity of the conglomerate stone, facilitating a dense colonization of mosses, lichens, and vascular plants. Over time, this biological activity accelerates biochemical deterioration, which is the dissolution of the stone matrix. In contrast, the northern parts of the cavea are exposed to direct and continuous solar radiation. In these areas, the primary threat is physical rather than biological.

The notable contrast between the two zones, moisture-driven biological decay in the southern sectors and solar-driven physical weathering in the northern parts, demonstrates that a uniform conservation treatment would be inadequate. The interventions require a targeted, effective conservation strategy, with diagnostic and treatment methods specifically adapted to the unique microclimatic conditions of each zone.

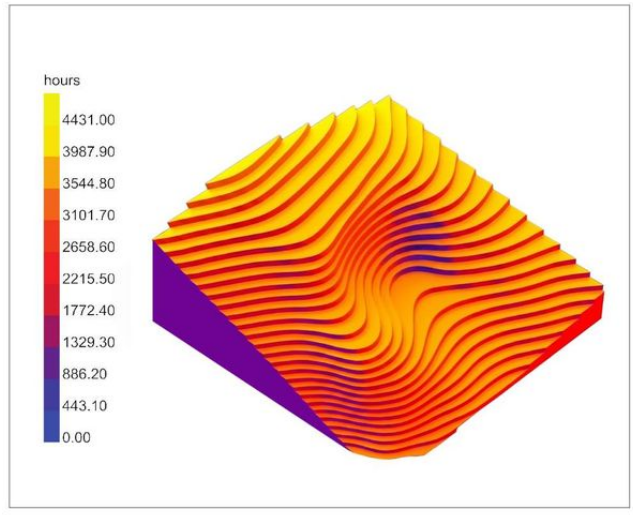


Figure 125. Sun exposure analysis in hours/year in the cavea area. Daigram by the author.



Figure 126. View of the theater remains after the 2007 wildfire. Source: Şahin, Arkeolojik Haber (2016).

Wildfire

The dense vegetation of the theater makes it extremely susceptible to modern environmental hazards. This vulnerability was explicitly realised during the severe wildfire that spread through the site in 2007. The dense Mediterranean flora and pine trees (*Pinus brutia*) covering the cavea served as a combustible fuel load, bringing intense flames and extreme heat into direct contact with the fragile ruins. The primary risk posed by the 2007 fire (Fig. 126) was not only aesthetic discolouration but also severe thermal shock to the masonry, which accelerated its degradation.

B. Biological Hazards

Vegetation

At present, the ancient theater emerges as the most critically vulnerable structure within the broader city, primarily due to its exceptionally high density of vegetation compared to the rest of the city's structures (Fig. 127, 128).

While vegetation growing in direct contact with the ruins is observed relatively less across other monuments of the ancient city, the theater's highly porous conglomerate stone and dry-stone joints have created an ideal, ecologically diverse habitat for aggressive plant growth. Therefore, this dense concentration of flora concentrates the site's most severe structural vulnerabilities within the theater, reflecting a complicated conservation challenge. However, the flora should not be considered merely as a threat to be eradicated, but as an essential component of the site's living character (*genius loci*) through specific case evaluations.

The uprooting of the vegetation could cause "desertification" of an archaeological site, which would be highly destructive. This not only diminishes the characteristics of the authentic landscape of the city, but also uproots the deep-rooted plants serving as structural consolidation, which could cause the sudden structural collapse.

In order to distinguish between vegetation that poses an unacceptable structural risk and flora that is ecologically valuable, this study utilises Maria Adele Signorini's Hazard Index (IP). Evaluated on a scale from 0 to 10, this index analyses each plant's life form, invasiveness, and root system architecture.

At the theater, highly dangerous woody species (IP ≥ 7) have been observed in the cavea seating part and the stage building. The aggressive root systems of these plants cause severe mechanical damage through "root wedging," forcibly widening the unmortared joints. Especially in the shaded southern sectors of the theater, this prolonged dampness accelerates destructive wet-dry cycles and biological colonisation.



Figure 127. Lentisk trees in the cavea. Photograph by the author.



Figure 128. Pine trees in the theater area. Photograph by the author.

Biological Surface Colonisation

The biological colonization of the theater's stone surfaces creates a remarkable vulnerability, acting as a primary catalyst for both chemical and physical decay.
Pioneer microorganisms, such as algae and fungi, cover the stone surface with thick, sponge-like layers (Fig. 129). Therefore, these organic layers significantly increase moisture retention within the porous stone. During their metabolic processes, they release natural acids that progressively dissolve the binding matrix of the stones, thus weakening the structural integrity of the blocks.

Moreover, this decaying organic matter creates a base layer of soil. This soil accumulation causes a critical physical vulnerability by allowing the roots of larger plants to take hold, which eventually leads to severe mechanical cracking and the displacement of the masonry. Lichens demonstrate a structurally complex stage of this biological succession. However, the role of lichens in heritage conservation is highly complex and widely debated. The reaction between the acid produced by lichens and the stone forms a hard mineral crust.

These organic layers have been considered one of the primary factors in deterioration; however current research indicates that this resilient layer can actually serve as a protective biological barrier, sheltering the vulnerable conglomerate from wind erosion and severe water runoff.

The distribution of this biological colonisation through the ancient theater is notably irregular, fundamentally by solar radiation. Due to the theater's orientation, the southern part of the cavea is consistently shaded, maintaining its humid microclimate. The less sun exposure on the southern cavea makes the area highly susceptible and an ideal base for the dense biological colonisation. Conversely, the northern part of the cavea is exposed to prolonged direct sunlight. While the dominant solar exposure inhibits the growth of biological organisms in the northern part, it subjects the material to temperature-driven vulnerabilities.

Ultimately, assessing the different conditions of the cavea parts regarding their microclimate conditions for each part establishes an essential approach for any proposal.



Figure 129. Mosses on the cavea stones. Photograph by the author.

C. Anthropogenic Hazards

Illicit Excavation and Dismantling of the Stone Blocks

The abandoned location of the ancient city caused its detachment from continuous maintenance and modern dense settlement, making it a highly defenceless target for looters and antiquities smugglers. Thereby, the targeted removal of architecturally and structurally significant elements constitutes a severe form of anthropogenic disturbance.

However, this case is documented in a legal investigation, which recorded the physical extraction of at least two conglomerate seating blocks from the lower rows of the cavea and a fractured marble architectural element from the stage building (Fig. 130). These displaced archaeological remains were later discovered abandoned along the path heading to Ahmetbeyli Beach, northwest of the Acropolis. This recent looting supports the probability that the valuable elements and architectural components of the theater had been stolen in the past. The most obvious evidence is the complete absence of the front row seats, which were probably stolen from the international antiquities market.

Stealing these architectural elements causes more than just cultural and historical damage. When stones are dismantled, such as the two conglomerate blocks from the lower seating rows of the cavea in 2014, it triggers a domino effect regarding the structural collapse. Due to its steep topography orientation, the theater is severely vulnerable to collapse compared to other stone structures on the site.

The removal of the seating blocks from the lower rows eliminates the structural support for the earth fill behind them. Once the block is dismantled, the exposed soil causes the shift and collapse of the cavea downward. The displacement of the cavea blocks act as a domino effect through the cavea due to the load transmission, and specifically affects the specific seating section recalled as *kerkis*. It is remarkable that the removal of just a single block in the design of the cavea supported by the inclined topography, causes a much more vulnerable condition than a free-standing wall. Consequently, it is essential to consider improving site management to prevent any further looting.

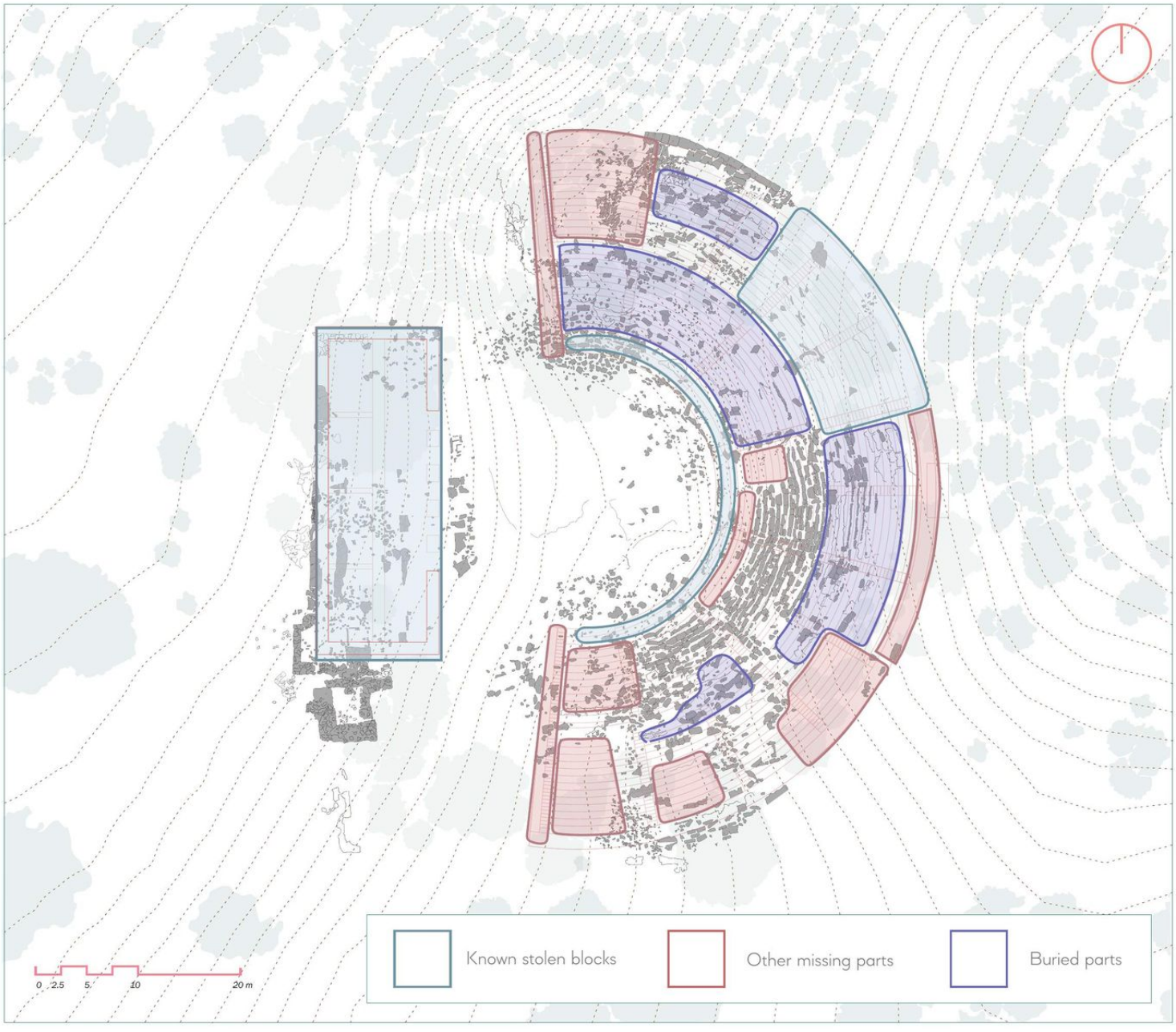


Figure 130. Mapping of dismantled, lost and slightly buried theater stones. Drawing by the author.



Figure 131. Visitors sitting on the theater blocks. Photograph by author.

Uncontrolled Visitor Access

The cavea reflects one of the most fragile structures among the civic monuments of the city. The complete absence of site and visitor access management at the ancient site causes uncontrolled access to the ancient theater's vulnerable structure. This unrestricted physical interaction is highly destructive for the fragile cavea structure (Fig. 131). As previously mentioned, the looting of the metal clamps caused the unmortared conglomerate blocks now rely entirely on the surface friction to stay in place. When visitors, especially large tour groups, repeatedly walk along the cavea to reach the upper rows, their foot traffic creates risks of stone displacement and compromises the stones' material integrity.

Therefore, the absence of defined paths as interpretative guidance for the visitors, could cause further structural collapses in the cavea section. Its fragile structure requires an active visitor management strategy that safely routes pedestrian traffic while preserving the site's authentic landscape.

Uncontrolled Agro-pastoral Activities

While the urban-scale analysis highlighted the general impact of the agro-pastoral activities across the city, this hazard presents a specific mechanical threat for the ancient theater. The dense grass and vegetation currently existing in the ruin, cavea serves as a grazing ground for sheeps and goats.

This pastoral activity causes continuous foot traffic across the %30 inclined on the fragile conglomerate blocks. Therefore, the continuous activity could cause direct mechanical damage on the cavea 's structure, fracturing the weakened edges of the unmortared seating steps. Furthermore, the accumulation of the goat disposals on the stone surfaces accelerates the degradation of the remains (Fig. 132).



Figure 132. Biological deposit due to agropastoral activites on the theater stones. Photograph by the author.

4.2.2 Intrinsic Factors (Vulnerabilities)

Construction Method and Structural Vulnerabilities

The theater's cavea was built directly onto the carved bedrock, exploiting the natural 30% slope of the hillside in order to diminish the need for massive artificial foundations. However, while this topographical integration is a hallmark of Hellenistic design, it simultaneously creates a severe intrinsic vulnerability to downward gravitational forces. In its original state, the dry-stone seating tiers were tightly locked together with metal clamps, and the massive weight of the upper rows was safely supported by the lower rows and the retaining walls (*analemmata*). Unfortunately, following the historical looting (spoliation) of these metal fasteners and the progressive collapse of the lower supporting rows, the upper sectors lost their critical basal support. Consequently, the continuous downward shear and thrust forces have triggered widespread structural slippage of the seating blocks (Fig 133, 134).

These continuous downward stresses cause the surviving seating blocks to crack, misalign, and progressively slide down the hillside, irreversibly altering the stepped profile of the theater (Fig. 135). Furthermore, the gravitational force and heavy surface runoff from the upper hill have transported massive amounts of sediment and organic debris downslope. This ongoing erosion and run-off of soils has progressively accumulated at the lower rows of the cavea under a thick layer of soil. This heavy, damp accumulated soil exerts a constant lateral earth pressure against the fragile masonry and causes persistent waterlogging. Therefore, the loss of the original orchestra floor level to burial constitutes a significant obstacle to understanding the theater's operational history.

Topographical Vulnerabilities and Structural Degradation Mechanisms of the Theater in Plan

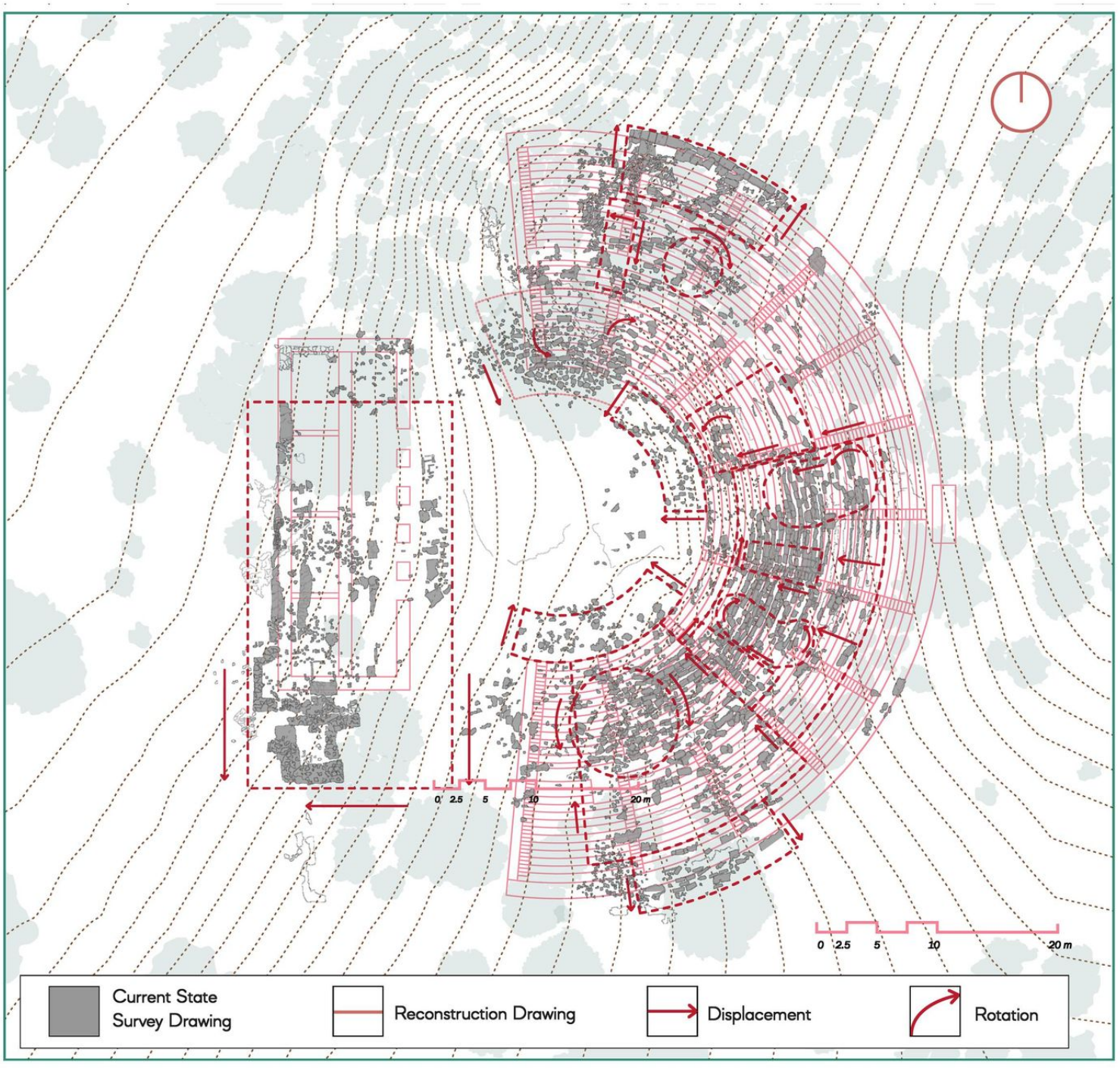


Figure 133. Theater structural vulnerabilities overlaid on the reconstruction plan. Drawing by the author.

Topographical Vulnerabilities and Structural Degradation Mechanisms of the Theater in Section

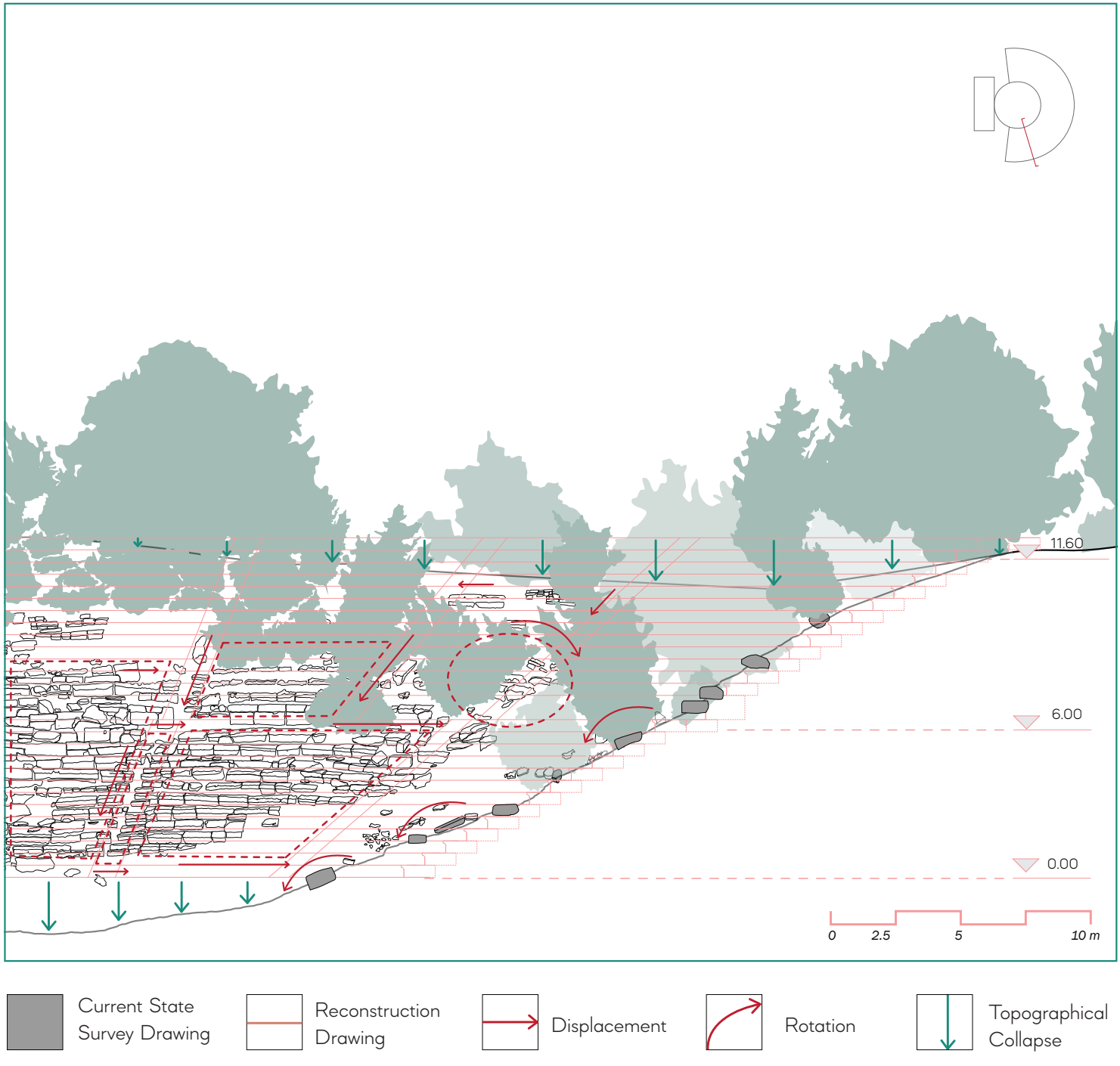


Figure 134. Theater structural vulnerabilities overlaid on the reconstruction section and current state. Drawing by the author.



Figure 135. Detail of collapsed blocks in the theater. Photograph by the author.

Type of Used Material

In the construction of the theater, the massive volume of stones had been used to host an estimated capacity of 3500 to 4000 spectators. The volumetric calculations obtained from the 3D laser scanning, approximately 3260 m3 local conglomerate stone were employed to construct only the cavea part. Additionally, the conglomerate was also employed also for the entire construction of retaining walls. Unlike that, the superstructure walls and the facade decorations of the building was constructed by the marble. This contrast reflects an inconsistency in the design regarding the material choice; the architects reservist the durable material primarily for the aesthetic and decorative purposes and the stage facade, while the primary static loads of the cavea was entrusted to the weaker conglomerate stone. Consequently, it should be noted that this material choice of conglomerate was not due to the absolute lack of resources or geographical necessity, but rather due to the engineering choice prioritizing cost and time efficiency over the structural preferences. Such decisions are classified as "severe intrinsic vulnerabilities" stemming from "the errors in structural logic or constructions". [83] During the construction of the theater of Notion, the material decisions of architects embedded the monuments' severest intrinsic vulnerability by themselves.

Beyond the static and mechanical vulnerabilities, the selection of the conglomerate stone triggered the latent intrinsic vulnerabilities that accelerated the theater's decay over the centuries. The material driven weaknesses are related with its two interconnected features; its heterogeneity and its high bioreceptivity with moisture retention capacity.

83. Marino, Il restauro archeologico, 53.



Figure 136. Conglomerate seating blocks showing deterioration and biological growth. Photograph by the author.

Heterogeneity

The conglomerate is quite heterogeneous, composed of various rock fragments bonded by a calcareous matrix. When the cavea stone is subjected to runoff water of the rain and load bearing stress, the matrix of the conglomerate easily dissolves and generates fractures. During the theater construction, the dry stone technique without mortar, the crumbling of the stone edges destroyed the friction between the blocks and their interlocking connections.



Figure 137. Vegetation growing on the theater stone. Photograph by the author.

Bioreceptivity and Moisture

The high bioreceptivity and moisture retention capacity of the conglomerate due to its high porosity and surface roughness, led to serious intrinsic vulnerabilities. (Fig. 136) Unlike the marble features, the high porous conglomerate acts like a sponge in terms of its moisture retention even during the dry Mediterranean summers.[84] This persistent moisture, combined with the rough and deteriorating surface of the conglomerate, creates ideal conditions for biological colonisation; vegetation growth was documented directly on the theater stones, where plant roots further penetrate and widen existing cracks (Fig. 137). Moreover, the rough surface of the deteriorating conglomerate functions as a natural trap for the windblown soil, atmospheric particles and the seeds.

84. Kristian Fabbri, Maria Catalano, and Andrea Ugolini, "Vegetation in Archaeological Areas: Risks, Opportunities, and Guidelines to Preserve or Remove: An Italian Case Study," *Sustainability* 17, no. 6 (2025): 2712. See also Alessia Cozzolino et al., "The Role of Lichens, Mosses, and Vascular Plants," *Plants* 11, no. 24 (2022): 3429.

4.3 Risk Assessment Matrix

URBAN SCALE

HAZARD (extrinsic)	X	VULNERABILITY (intrinsic)	=	RISK (combined effect of both factors)
Seismic activity	X	Construction method (dry-stone)	=	Building collapse.
Seismic activity	X	Topography & site exposure	=	Dislodged and overturned blocks
Wind & marine aerosols	X	Material: conglomerate (porosity)	=	Surface degradation
Water / rainfall	X	Topography & thin soil	=	Soil wash-down & strata erosion.
Water / rainfall	X	Terracing (interdependent dry-stone system)	=	Terrace collapse & scattering.
Vegetation / colonisation	X	Material: bioreceptivity	=	Root-wedging + biochemical decay.
Vegetation / colonisation	X	Construction (dry-stone joints)	=	Joint widening & block loss.
Fire / wildfire	X	Material: porous limestone & conglomerate	=	Cracking and fractures
Fire / wildfire	X	Topography & thin soil	=	Post-fire erosion.
Spoliation / stone robbing	X	Construction (load-bearing courses)	=	Structural disintegrity.
Illicit excavation	X	Topography & earthen cores	=	Heritage loss.
Vandalism	X	Material & open access	=	Site's legibility loss and defacement.
Uncontrolled visitor access	X	Construction (friction-held blocks)	=	Block displacement.
Agro-pastoral pressure	X	Topography & buried strata	=	Degradation on stone due to biological deposit and trampling.
Unauthorised land use & admin gap	X	Undesignated sensitive zones	=	Irreversible loss & severed link: roads and modern construction over legally undesignated zones cause irreversible material loss and sever the site, necropolis connection.

THEATER SCALE

HAZARD (extrinsic)	X	VULNERABILITY (intrinsic)	=	RISK (combined effect of both factors)
Water Rainfall	X	Cavea funnel geometry (lost drainage)	=	Water flow channels through the cavea.
Water (retained moisture)	X	Material: bioreceptivity	=	Colonisation via bioreceptivity
Microclimate and solar exposure	X	Cavea orientation (E–W)	=	Biological decay on the south cavea
Wildfire	X	Material + dense fuel load	=	Accelerating the degradation of the stones
Vegetation (high-IP woody roots)	X	Material & dry-stone joints	=	Unstabilizing and dislocation of the stones.
Surface colonisation (moss/lichen/algae)	X	Material: bioreceptivity	=	Accelerating the decay of the stones.
Illicit excavation & dismantling	X	Cavea geometry (inclined load transmission)	=	Domino collapse.
Uncontrolled visitor access	X	Construction (friction-held blocks)	=	Block displacement and stuctural collapse.
Agro-pastoral pressure	X	Material (fragile seating edges)	=	Edge fracturing & deposits.
Wind & marine aerosols	X	Material (porous cavea)	=	Accelerating the perforation decay of the stones.

05.

VEGETATION ANALYSIS : RISKS AND OPPORTUNITIES

5.1 Notion as an Archaeological Park

The abandonment of Notion in antiquity left the site vulnerable to deterioration; throughout the centuries of isolation, the site evolved into a landscape of considerable ecological diversity (Fig. 138). Currently, the city is more than an archaeological site; it is an integrated "archaeological landscape" (Fig. 139) where the ancient remains and vegetation exist in an inextricable symbiosis. As defined in Chapter 1, Notion is approached here as a living archaeological landscape, a place where natural processes and ancient remains have become mutually dependent over centuries of abandonment. The site is heavily covered by dense Mediterranean macchia, shrubs, and pine forests.

Managed coexistence, as defined in this study, refers to a site-management strategy that selectively retains vegetation where it stabilizes or enriches the ruin, and intervenes only where it demonstrably threatens structural integrity. A preliminary example of this approach is the utilization of the site by traditional agro-pastoral activities. Field survey data indicate that local flocks and sheep regularly graze on the site. Grazing naturally controls the overgrowth of herbaceous vegetation, eliminating the need for mechanical intervention. Furthermore, continuous sheep routes help maintain the pathways across the site.

The definition of an archaeological park is beyond its excavated monuments, also relying on the inseparable relationship between the architectural remains and their natural environment. [85] Such a relationship safeguards "the spirit of the place" and extends the site's authentic aesthetic value. [86] Ultimately, Notion as an archaeological park needs determining the balance between biological risks and and opportunities. Since modern approaches promote a "managed coexistence," instead of pursuing the "desertification" of the archaeological site by eradicating all flora, the management strategy must acknowledge vegetation as an essential partner, defining the atmosphere and



Figure 138. Vegetation on the theater. Photograph by the author.

85. Matteini and Ugolini, Il bisbiglio dei ricordi indefiniti, 29–55.
86. ICOMOS, The Quebec Declaration on the Spirit of Place (Québec: ICOMOS, 2008), para. 3.



Figure 139. Olive tree among the ruins. Photograph by the author.

preserving the "patina of time" on the ruins as the accumulated marks of age that give the site its particular character and make it irreplaceable.[87] The management of the relationship of the ecosystem with the architectural remains as an archaeological park should be guided by balancing the biological risks and beside ecological strategies. While certain invasive vascular plants pose the serious structural problems as root wedging and must be controlled, the other plant species offer some benefits. The undisturbed ruins, left unexcavated and uncleared, provide shelter and habitat for a range of local species, effectively functioning as natural refuges within the broader landscape. Hence, the sustainable site management can be preliminarily achieved case-by-case evaluation of the vegetation. A case-by-case methodology recognizes that not all plant species pose the same threat level to the archaeological remains. The vegetation analysis framework should investigate deeply the impact of flora determined by the specific characteristics of each species and their interaction with the archaeological remains. Therefore, each plant should be evaluated individually according to its life form, invasiveness, and root morphology. [88]

87. Cesare Brandi, Teoria del Restauro (Torino: Einaudi, 1977), 33–36.
88. Fabbri, Catalano, and Ugolini, "Vegetation in Archaeological Areas," 2712.

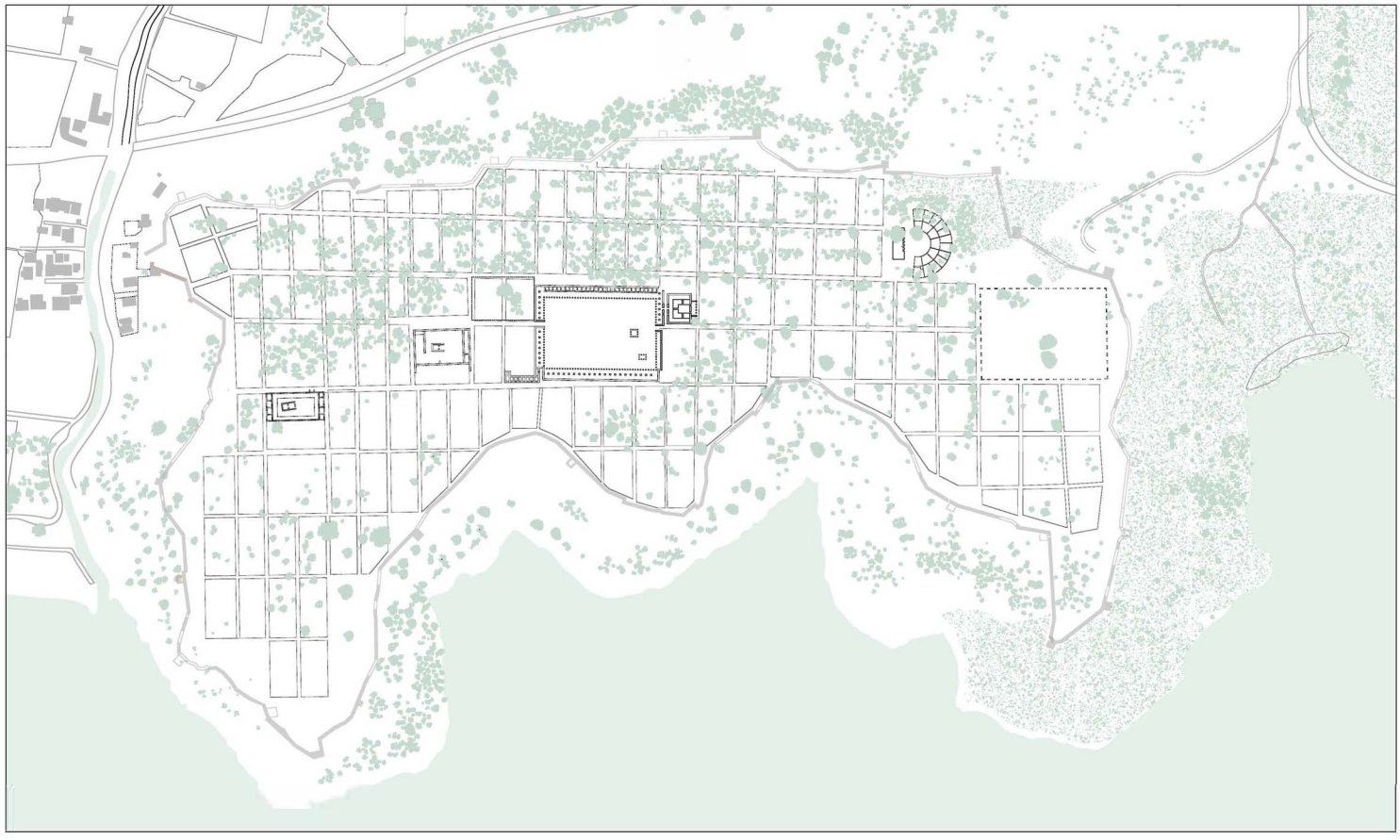


Figure 140. Greenery plan of Notion. Map by the author.

5.2 Existing Botanical Species in Notion

The implementation of the case-by-case methodology and assessment of the risk for each plant having a specific role on the archaeological remains, requires a comprehensive inventory of the existing flora at Notion ancient city (Fig. 140). The preliminary assessment regarding the plant species can be listed by the systematic classification throughout the entire Notion ancient city. The classification of these species extends beyond just botanical exercises and serves as the primary step for determining their *biological form*.

The vegetation species in entire landscape of Notion reflects the typical Mediterranean ecosystem and can be organized into some categories (Fig. 141) :

Trees

- Turkish Pine *(Pinus brutia)*
- Cilician Fir *(Abies cilicica)*
- Wild Olive *(Olea europaea)*
- Lebanon Cedar *(Cedrus libani)*
- Carob Tree *(Ceratonia siliqua)*
- Fig Tree *(Ficus carica)*
- Laurel Tree / Bay Laurel *(Laurus nobilis)*
- Greek Strawberry Tree *(Arbutus andrachne)*
- Terebinth Tree *(Pistacia terebinthus)*
- Mandarin Orange *(Citrus reticulata)*
- Pomegranate *(Punica granatum)*
- Kermes Oak (*Quercus coccifera*)



Figure 141. Some vegetation species from the site. Photos by the author.

Sub-shrubs and Suffruticose Plants

- Turkish Oregano *(Origanum onites)*
- Rosemary *(Salvia rosmarinus)*
- Thyme *(Thymus vulgaris)*
- Lamb's Ear *(Stachys cretica)*
- Camelthorn *(Alhagi maurorum)*

Microflora and Non-Vascular Plants

- Lichen *(Lichens)*
- Moss *(Bryophyta)*

Herbaceous Plants and Grasses

- Artichoke Thistle *(Cynara cardunculus)*
- Mullein *(Verbascum sp.)*
- Annual Ryegrass *(Lolium multiflorum)*
- Orchard Grass *(Dactylis glomerata)*
- Compact Brome *(Bromus madritensis)*
- Slender Wild Oat *(Avena barbata)*
- False Barley *(Hordeum murinum)*
- Spanish Brome *(Bromus tectorum)*
- Poppy / Red Poppy *(Papaver rhoeas)*
- Ovate Goatgrass *(Aegilops ovata)*
- Spreading Rush *(Juncus effusus)*
- Wild Hemp *(Cannabis ruderalis)*
- Wild Grasses *(Poaceae family)*

Shrubs and Maquis

- Kermes Oak (*Quercus coccifera*)
- Lentisk / Mastic Tree *(Pistacia lentiscus)*
- Myrtle *(Myrtus communis)*
- Buckthorn *(Rhamnus alaternus)*
- Dwarf Juniper *(Juniperus communis)*
- Greek Strawberry Tree *(Arbutus andrachne)*
- Terebinth Tree *(Pistacia terebinthus)*
- Laurel Tree / Bay Laurel *(Laurus nobilis)*

5.3 Vegetation Assessment in the Theater



Figure 142. Theater surrounded with vegetation, its photo angle taken from the Bouleuterion. Photograph by the author.

The vegetation assessment for the conservation strategy in the ancient theater of Notion (Fig. 142), the vegetation assessment was structured around an approach that avoids the complete eradication of flora without a case-by-case evaluation.[89] The conservation principles dictate that removing all the vegetation could cause "desertification" on the archaeological site. Therefore, the approach to be implemented on the theater aims a coexistence in harmony of the archaeological remains and the vegetation. [90] In order to achieve that, the vegetation in the theater zone systematically, should be analysed through a case-by-case evaluation, considering multiple parameters. Therefore, it is essential to assess the vegetation species as a preliminary step before starting to evaluate the hazard index (IP) of the vegetation. [91]

89. Tessa Matteini, 'La natura dei ruderi,' Architettura del paesaggio, no. 11 (2004): 50–51.
90. Georg Simmel, 'Two Essays: The Handle, and The Ruin,' trans. R. H. Weingartner, The Hudson Review 11, no. 3 (1958): 379–382.
91. Fabbri, Catalano, and Ugolini, "Vegetation in Archaeological Areas," 2712.

5.3.1 Vegetation Species Map

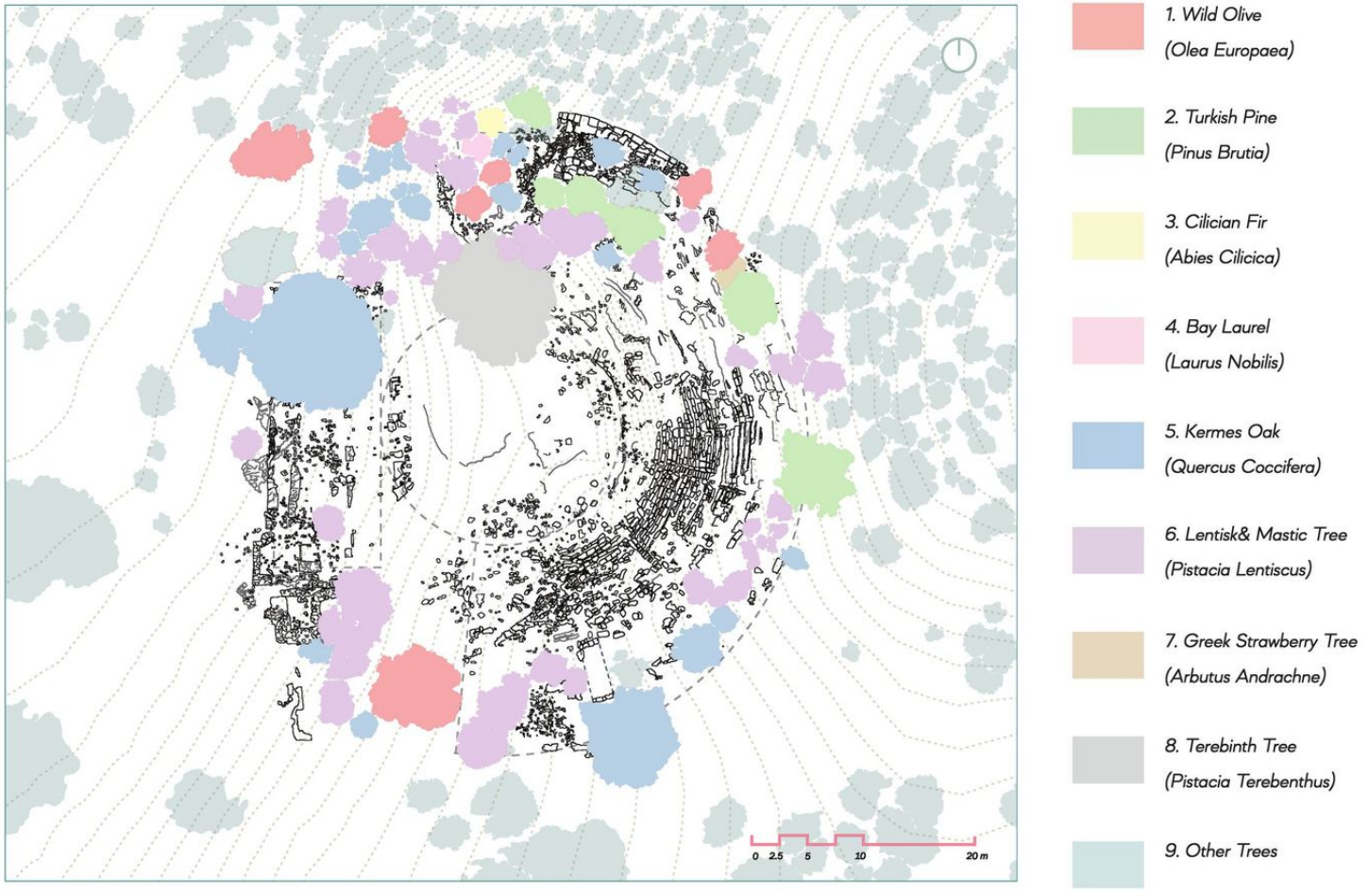


Figure 143. Mapping of tree types in the theater area. Diagram by the author.

The mapping of the vegetation (Fig. 143) species is a fundamental step for formulating the effective management and decision-making process regarding the natural environment. Since the vegetation can cause bio-deterioration and severe mechanical lesions to the artifacts, it is crucial to have a deeper understanding of the mechanisms underlying plant-stone interactions. The requirement of maintaining the structural integrity of the structure could clash with preserving the botanical identity. In order to resolve this conflict, it is requires the integrating the monuments with the natural landscape. Therefore, mapping of the plant species identified during the site visit and focusing especially to the theater's cavea, the primary objectives to determine exactly which plant types are existing in relationship with the remains.



Figure 144. Representing *patina* of the theater's blocks. Photograph by the author.

5.3.2 Hazard Index (IP) Methodology

Vegetation in archaeological sites presents a dual condition: it is simultaneously a source of biodeterioration and a carrier of ecological and aesthetic value from past (Fig. 144). Managing this tension is central to any conservation decision, as the need to protect architectural remains can directly conflict with the ecological and cultural interest of the plant species present on the site. The integration of monuments with the natural landscape is now a primary aspect in the management of archaeological sites, and the botanical landscape deserves the same attention given to the conservation of the monuments themselves. The optimal management of native plant species compatible with the ancient artifacts is therefore complementary to the protection of the monuments and a part of an essential restoration project.

The Hazard Index (I. P.) of species is a numerical index correlated with the impact of a species on architectural structures. It represents a primary approach to balancing the preservation of architectural artefacts with the scientific and ecological interests of the plant communities present within the same context. In order to identify an intervention strategy for the dense and diverse vegetation affecting the amphitheater structures, the method established by Signorini in 1995.[92] This system translates biological characteristics of each species into numerical values, allowing a structured and comparable assessment of the potential hazard each plant poses to the architectural fabric (Fig. 145).

92. Maria Adele Signorini, "L'Indice di Pericolosità delle piante infestanti nelle aree monumentali: un contributo del botanico," in Le piante infestanti nei siti monumentali, ed. G. Caneva (Fiesole: Nardini, 1995), 45–58.

Generally speaking, it can be said that the intrinsic hazard of each species increase with three parameters to be evaluated for each individual species:

1) Biological Category

It is determined by the duration of the life cycle and the habit of the species. The distinction is made into annual, biennial, or perennial plants, while the habit of the plant can be herbaceous, shrubby, liana-like/climbing, and arboreal (tree-like).

2) Invasiness and Vigour

The type of vegetative propagation of the plant is considered. In woody plants, in particular, the capacity to produce suckers is determined, that is, the part of a plant in the form of a shoot that develops directly on the trunk or at the base of the tree, or sometimes even directly from the root, occasionally following the cutting of the main stem. The suckering capacity of woody plants is particularly dangerous for the interaction with the masonry of the structure because it allows the plant to expand and survive potential cutting, making its elimination difficult. Furthermore, the plant's vigour is considered, which refers to its vegetative development, including its spread across the surface, as well as its growth in height and depth.

TABELLA 1
Schema di classificazione delle specie per la valutazione della pericolosità e il calcolo dell'Indice di Pericolosità.

Forma biologica	Invasività e vigore	Apparato radicale
0 – Piante annue	0.0 – Non reptanti a sviluppo normale	0.0.0 – senza fittone 0.0.1 – con fittone debole 0.0.2 – con fittone robusto
	0.1 – Reptanti a sviluppo normale	0.1.0 – senza fittone 0.1.1 – con fittone debole 0.1.2 – con fittone robusto
	0.2 – A sviluppo molto vigoroso	0.2.0 – senza fittone 0.2.1 – con fittone debole 0.2.2 – con fittone robusto
1 – Piante bienni	1.0 – Non reptanti e reptanti	1.0.0 – senza fittone 1.0.1 – con fittone debole 1.0.2 – con fittone robusto
2 – Perenni erbacee	2.0 – Muschi e Licheni	2.0.0 – senza fittone
	2.1 – Erbe a crescita non invadente, oppure a sviluppo gracile	2.1.0 – senza fittone 2.1.1 – con fittone debole 2.1.2 – con fittone robusto
	2.2 – Erbe a crescita invadente, oppure a sviluppo molto vigoroso	2.2.0 – senza fittone 2.2.1 – con fittone debole 2.2.2 – con fittone robusto
3-4 – Arbustive	3.0 – Suffrutici	3.0.0 – poco invadente 3.0.1 – mediamente invadente 3.0.2 – molto invadente
	4.0 – Arbusti non polloniferi o di piccola taglia	4.0.0 – poco invadente 4.0.1 – mediamente invadente 4.0.2 – molto invadente
	4.1 – Arbusti polloniferi	4.1.0 – poco invadente 4.1.1 – mediamente invadente 4.1.2 – molto invadente
	4.2 – Arbusti con polloni radicanti	4.2.0 – poco invadente 4.2.1 – mediamente invadente 4.2.2 – molto invadente
5 – Liane	5.0 – Non pollonifere	5.0.0 – poco invadente 5.0.1 – mediamente invadente 5.0.2 – molto invadente
	5.1 – Pollonifere	5.1.0 – poco invadente 5.1.1 – mediamente invadente 5.1.2 – molto invadente
6 – Alberi	6.0 – Non polloniferi	6.0.0 – poco invadente 6.0.1 – mediamente invadente 6.0.2 – molto invadente
	6.1 – Con polloni di ceppaia	6.1.0 – poco invadente 6.1.1 – mediamente invadente 6.1.2 – molto invadente
	6.2 – Anche polloni radicali	6.2.0 – poco invadente 6.2.1 – mediamente invadente 6.2.2 – molto invadente

Figure 145. The Hazard Index (IP) method for invasive plants. Source: Signorini (1996), 7–14.



Figure 146. The different species of vegetation on the cavea, May 2026. Photograph by the author.

3) Characteristics of the root system

Two types of root systems are distinguished: taproot systems, which have a primary root that dominates the others in its ability to penetrate the soil; and fasciculated (fibrous) systems, composed of numerous roots with equal penetration capacity that all remain more or less superficial. Taproot systems are generally more dangerous than ones without taproot, although for woody plants, a fibrous system could prove more dangerous because it has a broader area of influence on the structure's masonry.
Considering the parameters described above, for each plant species present in the amphitheater, three numerical indices were identified corresponding to biological category invasiveness and vigour, and characteristics of the root system. The Hazard Index generated at the end of this assessment constitutes the sum of the three parameters and can range from a minimum of 0, which corresponds to not crawling annual plants without taproot, to a maximum of 10, representing trees with radical suckers and a very intrusive root system.
The resulting IP index value, even if it is identical for different species, does not actually carry the same meaning. This is because the index captures the biological potential of a species in isolation, but the actual risk to the structure depends on how that potential interacts with the specific conditions of each location. The specific characteristics of the species (Fig. 146, 147) must be considered, such as the duration of the life cycle and its habit; the dimension and danger level of the root system; the invasiveness and vigour of the plant, as well as extrinsic characteristics, namely the plant's position in relation to the artefact. In other words, two species sharing the same IP value may require entirely different responses depending on where they grow and how they interact with the masonry. In general, three categories can be defined:

- IP index between 0 and 3 indicates not particularly hazardous species, which can be generally negligible in vegetation control operations;
- IP index between 4 and 6 indicates moderately dangerous species, and the necessity to intervene on them must be evaluated on a case-by-case basis;
- IP index of 7 and above indicates highly dangerous species, which as a general rule require targeted removal or containment.

In this context, additional criteria developed in contemporary Italian restoration theories, particularly the *active conservation* frameworks based on the abundance of species detected in the area and their aesthetic and/or cultural value, were also taken into consideration alongside the biological threat defined by Signorini.[93] The abundance and spatial coverage of the species is evaluated according to the following scale, designed to quantify the actual biological pressure on the site:

- Rare or scarcely abundant species (minimal physical pressure);
- Moderately abundant or localized species;
- Highly abundant and dominant species.

The aesthetic and landscape value is considered based on the species' appearance throughout the year and its contribution to the site's identity:

- Unattractive plants with inconspicuous flowers that lack cultural value and create a sense of severe neglect. Many species commonly identified as "weeds" belong to this category;
- Moderately attractive plants. This category can include plants that are attractive only during certain periods of the year (e. g., during blooming), or plants that are pleasant but ephemeral, with unappealing foliage, or that remain dry for most of the year, acting merely as a neutral green background;
- Decidedly pleasant plants throughout the entire year, due to the characteristics of their flowers and leaves, which strongly support the *Genius Loci* (spirit of the place) and the *romantic ruin* aesthetic.[94] This category includes all plants commonly and commercially used as ornamentals, as well as anachronistic veteran trees that provide microclimatic shading for visitors.

These additional parameters, the abundance of the species and its aesthetic and landscape value, become decisive precisely when the IP index alone is insufficient to determine whether intervention is justified. When deciding whether to remove a plant, in addition to the indications provided by the hazard index (IP index), it is extremely important to consider the potential for causing mechanical or chemical damage to the artefact incurred during weeding operations. This directly relates to the vulnerability of the architectural substrate, recognizing that the intervention itself can sometimes be more destructive than the biological presence.[95] Based on this, one must evaluate whether it is truly worth risking damage to the artefact, or if it might be better to seek alternative solutions without arbitrary interventions.

The scheme on the left is the scheme defined by Signorini to define the numerical values for calculating the Hazard Index (I. P.).

Greek Strawberry Tree (Arbutus andrachne) - Hazard Index / Indice di Pericolosità

	Characteristics	*Code*	*Score*
Biological Form	*Shrubs*	*4.1.1*	*4*
Invasiveness and vigor	*Suckering*	*4.1.1*	*1*
Root System	*Moderately invasive (Mediamente invadente)*	*4.1.1*	*1*
Total Hazard Index			*6*

93. Morezzi, Vagnarelli, and Borgioli, Ruderi e vegetazione, 20–39.
94. Marino, Il restauro archeologico.
95. Caneva, Hosseini, and Bartoli, "Risk, Hazard, and Vulnerability", 217-229.



Figure 147. Greek strawberry tree (Arbutus andrachne). Photograph by the author.

Prioritizing Trees for Specific Interventions:

- Specific Interventions for Kermes Oak
- Specific Interventions for Terebinth
- Specific Interventions for Turkish Pine
- Specific Interventions for Wild Olive

Based on the multi-factor methodology which combining IP, proximity, aesthetics, and advanced biomechanical assessments like VTA and SIA; it is prioritized four specific tree species for tailored interventions.

Intervention Strategies for Trees

- Defining the vegetation species

- Hazard Index (IP) Methodology + Landscape value of the plant : Aesthetic Value of the Plant + Abundance of the Plant

  - Biological Category
  - Invasiness and Vigour
  - Characteristics of the root system

- Proximity of vegetation to remains
- Age of the trees
- Case-by Case Evaluation — Trees — Shrubs — Moss and Lichens

5.3.3 IP Assessment in the Theater

High Hazard Trees (Category 6)

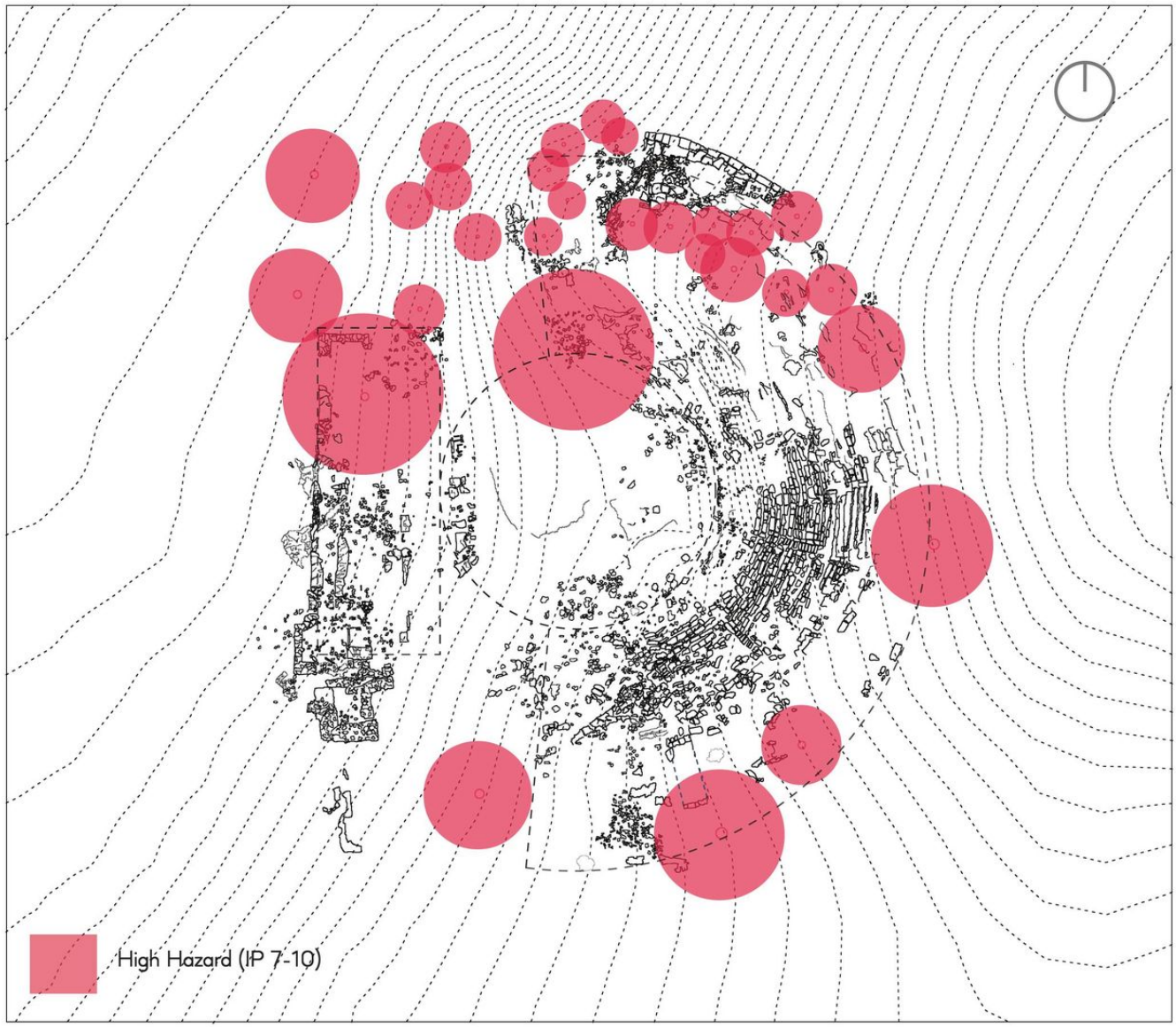


Figure 148. IP hazard mapping of trees in the theater. Map by the author.

High Hazard Trees in the Theater:

Wild Olive *(Olea Europaea)*

Turkish Pine (*Pinus Brutia*)

Bay Laurel *(Laurus Nobilis)*

Carob Tree *(Ceratonia Siliqua)*

Cilician Fir *(Abies Cilicica)*

Trees (Category 6)

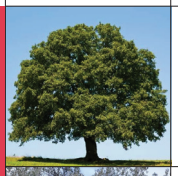
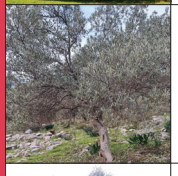
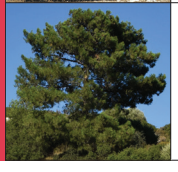
	TREE SPECIES	CHARACTERISTICS	BIOLOGICAL CATEGORY (Forma biologica)	INVASIVENESS (Invasività)	ROOT SYSTEM (Apparato radicale)	HAZARD INDEX (I.P.)
	KERMES OAK (Quercus coccifera)	Family: Fagaceae Genus: Quercus Species: Quercus coccifera Typology: Perennial	Tree (Alberi - Cat. **6**)	Radical suckers (Polloni radicali - Cat. 6.**2**)	Robust taproot / Very intrusive (Con fittone robusto / Molto invadente) - Cat. 6.2.**2**)	IP: 6 + 2 + 2 = **10** (Highly Dangerous) FREQ . = +++
	WILD OLIVE (Olea europaea)	Family: Oleaceae Genus: Olea Species: Olea europaea Typology: Perennial	Tree (Alberi - Cat. **6**)	With stump sprouts (Con polloni di ceppaia - Cat. 6.**1**)	Robust taproot / Very intrusive (Con fittone robusto - Cat. 6.1.**2**)	IP: 6 + 1 + 2 = **9** (Highly Dangerous) FREQ . = +
	CILICIAN FIR (Abies Cilicica)	Family: Pinaceae Genus: Abies Species: Abies cilicica Typology: Perennial	Tree (Alberi - Cat. **6**)	Not sucker (Non polloniferi - Cat. 6.**0**)	Robust taproot / Very intrusive (Con fittone robusto - Cat. 6.0.**2**)	IP: 6 + 0 + 2 = **8** (Highly Dangerous) FREQ . = +
	TEREBINTH TREE (Pistacia Terebenthus)	Family: Anacardiaceae Genus: Pistacia Species: Pistacia terebinthus Typology: Perennial	Small tree / Large shrub (Alberi - Cat. **6**)	Not sucker (Non polloniferi - Cat. 6.**0**)	Robust taproot / Very intrusive (Con fittone robusto - Cat. 6.0.**2**)	IP: 6 + 0 + 2 = **8** (Highly Dangerous) FREQ . = +
	TURKISH PINE (Pinus brutia)	Family: Pinaceae Genus: Pinus Species: Pinus brutia Typology: Perennial	Tree (Alberi - Cat. **6**)	Not sucker (Non polloniferi - Cat. 6.**0**)	Robust taproot / Very intrusive (Con fittone robusto - Cat. 6.0.**2**)	IP: 6 + 0 + 2 = **8** (Highly Dangerous) FREQ . = ++

Figure 149. IP assessment table of trees in the ancient theater. Table by the author.

Moderate and Low Hazard Trees (Category 3-4)

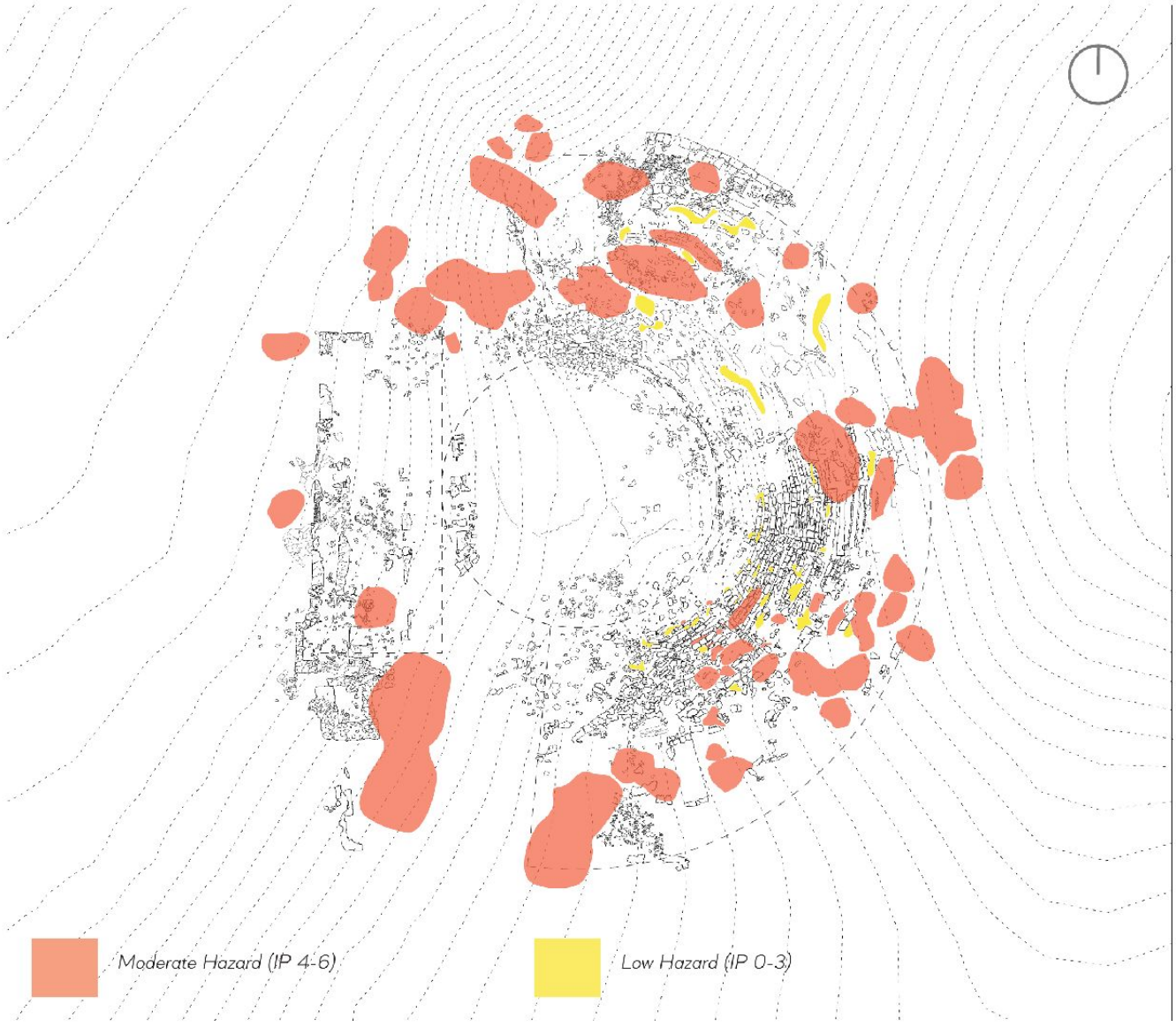


Figure 150. IP hazard mapping of shrubs in the theater. Map by the author.

Moderate-Low Hazard Shrubs & Maquis in the Theater:

Bay Laurel	Greek Strawberry Tree	Thorny Burnet
Lentisk / Mastic Tree	Spanish Broom	Rosemary

Shrubs and Suffruticose (Category 3-4)

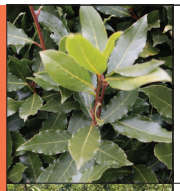
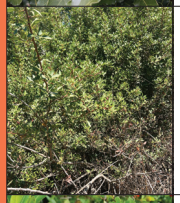
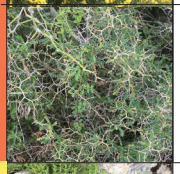
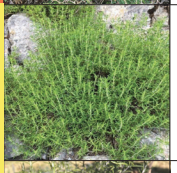
	BAY LAUREL	Family: Lauraceae Genus: Laurus Species: Laurus nobilis Typology: Perennial	Shrub (Arbustive - Cat. **4**)	Suckering shrub (Arbusti polloniferi - Cat. 4.**1**)	Slightly taproot / Intrusive (Con fittone debole / mediamente invadente - Cat. 4.1.**1**)	IP: 4 + 1 + 1 = **6** (Moderately Dangerous) FREQ . = + A.V. = ***
	LENTISK/MASTIC TREE (Pistacia lentiscus)	Family: Anacardiaceae Genus: Pistacia Species: Pistacia lentiscus Typology: Perennial	Shrub (Arbustive - Cat. **4**)	Not suckering shrub (Arbusti non polloniferi - Cat. 4.**0**)	Robust taproot / Very intrusive (Con fittone robusto / molto invadente - Cat. 4.0.**2**)	IP: 4 + 0 + 2 = **6** (Moderately Dangerous) FREQ . = +++ A.V. = *
	GREEK STRAWBERRY TREE	Family: Ericaceae Genus: Arbutus Species: Arbutus andrachne Typology: Perennial	Shrub (Arbustive - Cat. **4**)	Not suckering shrub (Arbusti non polloniferi - Cat. 4.**0**)	Robust taproot / Very intrusive (Con fittone robusto / molto invadente - Cat. 4.0.**2**)	IP: 4 + 0 + 2 = **6** (Moderately Dangerous) FREQ . = + A.V. =***
	SPANISH BROOM	Family: Fabaceae Genus: Spartium Species: Spartium junceum Typology: Perennial	Shrub (Arbustive - Cat. **4**)	Not suckering shrub (Arbusti non polloniferi - Cat. 4.**0**)	Robust taproot / Very intrusive (Con fittone robusto / molto invadente - Cat. 4.0.**2**)	IP: 4 + 0 + 2 = **6** (Moderately Dangerous) FREQ . = + A.V. = ***
	THORNY BURNET	Family: Rosaceae Genus: Sarcopoterium Species: Sarcopoterium spinosum Typology: Perennial	Subshrub (Suffrutici - Cat. **3**)	Suffrutici (Cat. 3.**0**)	Robust taproot / Very intrusive (Con fittone robusto / molto invadente - Cat. 3.0.**2**)	IP: 3 + 0 + 2 = **5** (Moderately Dangerous) FREQ . = + A.V. = *
	THYME	Family: Lamiaceae Genus: Thymus Species: Thymus spp. Typology: Chamaephyte (Dwarf Shrub)	Subshrub (Suffruticose) (Cat. **3**)	Low invasiveness (Poco invadente) (Cat. 3.**0**)	Without Taproot / Not Intrusive (Cat. 3.0.**0**)	IP: 3 + 0 + 0 = **3** (Low Hazard / Poco pericolose) FREQ . = +++ A.V. = *
	ROSEMARY	Family: Lamiaceae Genus: Salvia Species: Salvia rosmarinus Typology: Chamaephyte	Subshrub (Suffruticose) / Dwarf Shrub (Cat. **3**)	Low invasiveness (Poco invadente) (Cat. 3.**0**)	Without Taproot / Not Intrusive (Cat. 3.0.**0**)	IP: = 3+0+0 = **3** (Low Hazard / Poco pericolose) FREQ . = +++ A.V. = *
	OREGANO	Family: Lamiaceae Genus: Origanum Species: Origanum spp. Typology: Hemicryptophyte / Chamaephyte	Perennial Herb / Subshrub (Suffruticose) (Cat. **3**)	Low invasiveness (Poco invadente) (Cat. 3.**0**)	Without Taproot / Not Intrusive (Cat. 3.0.**0**)	IP: = 3+0+0 = **3** (Low Hazard / Poco pericolose) FREQ . = +++ A.V. = *

Figure 151. IP assessment table of shrubs in the ancient theater. Table by the author.

Cryptogams and Lower Organisms (Category 1-2)

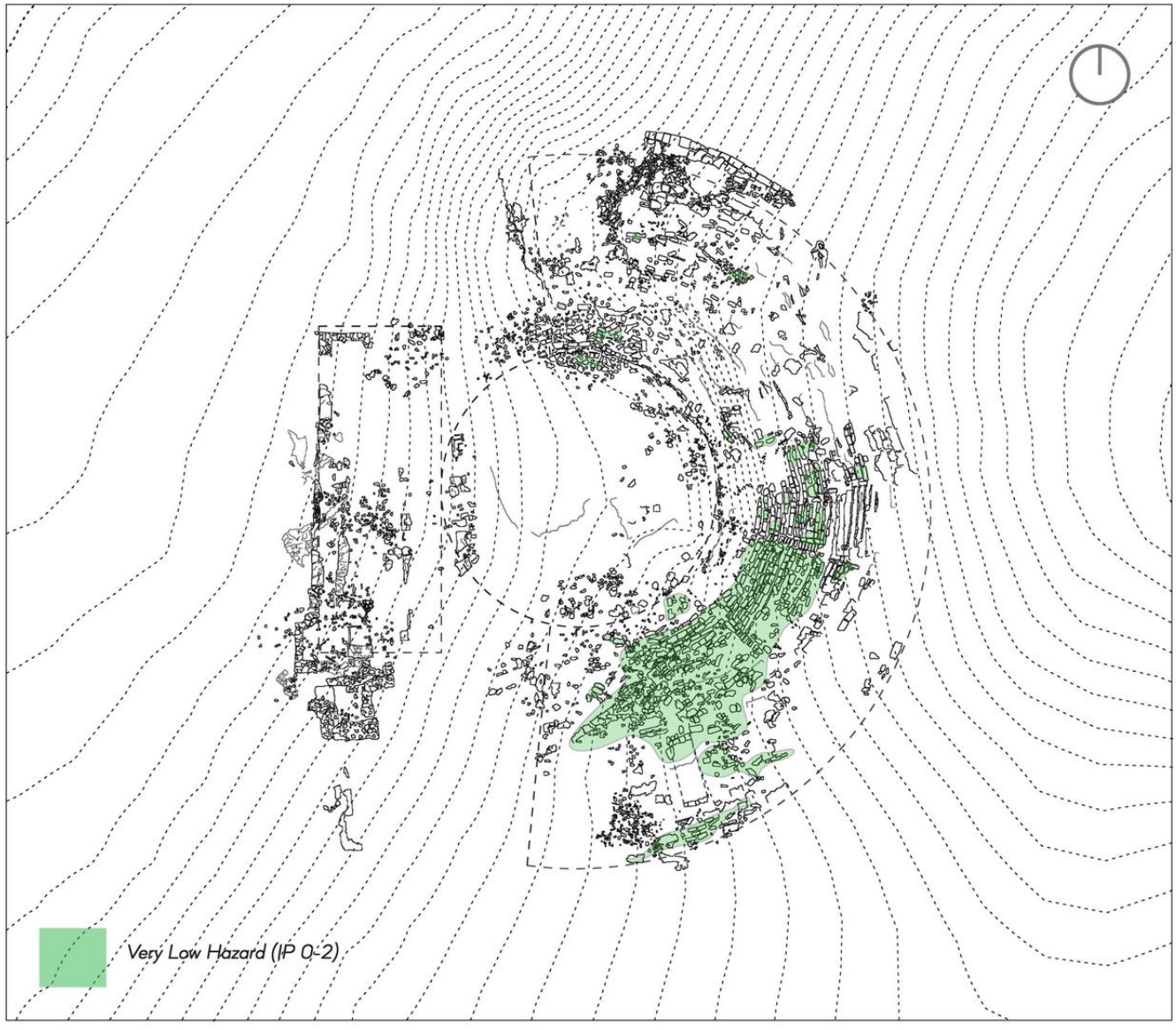


Figure 152. IP hazard mapping of lower vegetation and cryptograms in the theater. Map by the author.

Very Low Hazard Cryptogams and Lower Vegetations :

Cryptogams
(Mosses and Lichens)

Microflora
(Algae, Cyanobacteria, Fungi)

Cryptogams and Lower Organisms (Category 1-2)

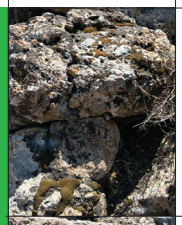
	TREE SPECIES	CHARACTERISTICS	BIOLOGICAL CATEGORY (Forma biologica)	INVASIVENESS (Invasività)	ROOT SYSTEM (Apparato radicale)	HAZARD INDEX (I.P.)
	MOSS	Division: Bryophyta Family: Various (e.g., Pottiaceae) Species: Undetermined bryophyte Typology: Cryptogam /	Mosses - Cat. **2**	Superficial / Non-invasive (Cat. 2.**0**)	Without taproot / Not intrusive (Senza fittone / Rhizoids only - Cat. 2.0.**0**)	IP: 2 + 0 + 0 = **2** (Low Hazard) FREQ . = +++ A.V. = *
	LICHEN	Category: Lichenized Fungi Family: Various (e.g., Parmeliaceae) Species: Undetermined crustose lichen	Lichens - Cat. **2**	Superficial / Non-invasive (Cat. 2.**0**)	Without taproot (Senza fittone - Cat. 2.0.**0**)	IP: 2 + 0 + 0 = **2** (Low Hazard) FREQ . = +++ A.V. = *

Figure 153. IP assessment table of lower vegetation and cryptograms in the ancient theater. Table by the author.

LEGEND

- 10 ≥ IP ≥ 7 — *High Hazard*
  6 ≥ IP ≥ 4 — *Medium/ Moderately Hazard*
  3 ≥ IP > 2 — *Low Hazard*
  2≥ IP ≥ 0 — *Very Low Hazard*

  Signorini's Indice di Pericolosita Approach

- *Abundance (+)*
  + : Rare or scarcely abundant in the area.
  ++ : Moderately abundant or localized.
  +++ : Highly abundant and widely distributed.

  Signorini's Abundance of the Plant Approach

- *Aesthetic Value (*)*
  * : Unattractive plants (often considered weeds) with inconspicuous features.
  ** : Moderately attractive plants (appealing only during a limited blooming period).
  *** : Decidedly pleasant plants year-round (often considered ornamental).

  Signorini's Aesthetic Value of the Plant Approach



Figure 154. Catalogue of the individual trees assessed in the theater. Photographs by the author.

5.3.4 Tree Proximity Analysis to the Remains

It is considered that vegetation intervention strategies for the theater must not be based only on IP values; rather a detailed evaluation of their spatial distribution is essential for developing more accurate intervention proposals. Therefore, alongside the assessment of vegetation species and their IP values, a case-by-case analysis of their location related to the archaeological remains will lead to more sound and sustainable intervention decisions.

Three levels of compatibility with the architectural remains were identified: 'good level' for plants situated away from archaeological features or in non-sensitive areas; 'fair level' for those located in proximity to the structures; and 'critical level' for vegetation growing directly on or adjacent to the remains. The level of criticality was determined by factoring in the hypothetical zones of influence of root systems, which vary in extent depending on the size and maturity of the plant, and their specific proximity to the remains of the seating blocks in the theater's cavea (Fig. 154, 155).

Consequently, it has been assessed that plants growing in areas with earthen fill present a relatively lower risk compared to those growing near stone remains and cavea blocks, given their limited direct contact with the stone fabric of the theater blocks. This analysis determines the methodology for the proposed intervention strategies; specifically, the intervention decisions for plants in close contact with stone elements will differ significantly from those situated only in soil.

Tree Proximity Mapping

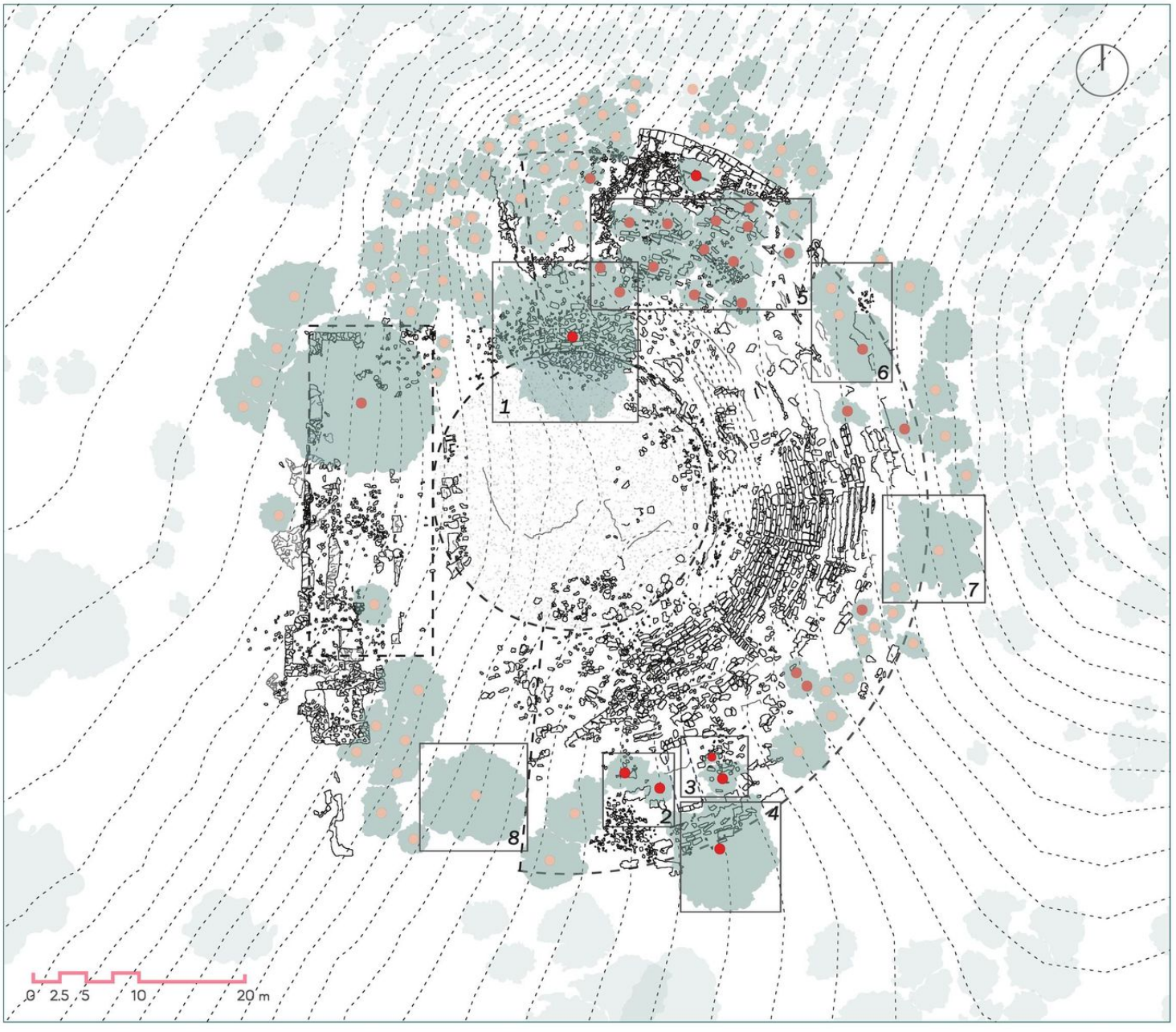


Figure 155. Compatibility between architectural structure and vegetation structure. Map by the author.

5.3.5 Tree Age Analysis

A prior intervention campaign conducted in 2017 targeted the vegetation at the cavea of the ancient theater, focusing particularly on pine trees and mastic trees. The deep-rooted trees (such as pines) that threatened to dislodge cavea blocks as seating rows were being intervented. Such trees have been trunk-cut and the herbicide was applied to their stumps solely to prevent these damaging effects. The team only aimed to make intervention on these plants causing physical harm to the monuments.

However, 2024 satellite imagery and the photogrammetry generated during the 2025 site visit prove that vegetation is growing back in the exact areas treated in 2017 (Fig. 156, 157,158). The fact that this new growth is once again mostly pine and mastic, suggests preventative interventions used weren't effective.

At present, as we develop new intervention proposals for the vegetation in the theater's cavea, it is crucial to take into account the age of the plants. Since the older and deeper roots eventually act as a "flexible connective issue" that holds the structure together, effectively becoming "consolidating vegetation"; the young trees have not yet developed these deep, thick woody root systems, so that dealing with them does not carry the same structural risks. [96]

The team of Christopher Ratté had led an intervention campaign during 2017 that was aiming the vegetations, especially pine trees and mastic trees, at the cavea of the ancient theater. The deep-rooted trees (such as pines) that threatened to dislodge cavea blocks as seating rows were being intervented. Such trees has been trunk-cut and the herbicide was applied to their stumps solely to prevent these damaging effects. The team only aimed to make intervention on these plants causing the physical harm to the monuments. However, 2024 satellite imagery and the photogrammetry has been generated during the 2025 site visit prove that vegetation is growing back in the exact areas treated in 2017 (Fig. 159).

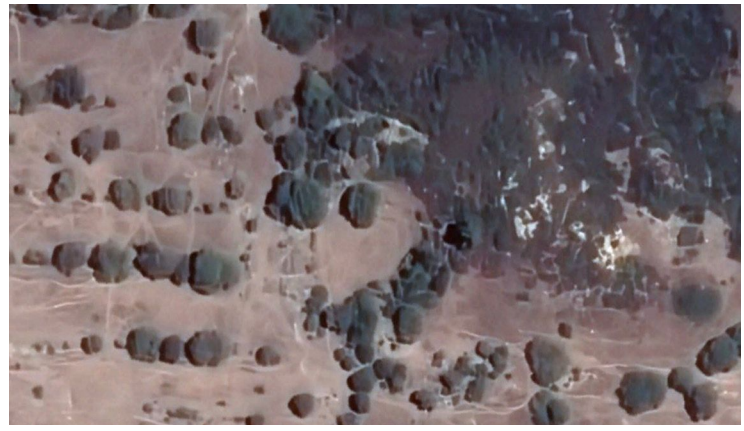


Figure 156. Satellite image of the theater at Notion, 2016.
Source: Google Earth, "Notion Ancient City," imagery © 2026 Google, captured 2016, accessed April 22, 2026.



Figure 157. Satellite image of the theater at Notion, 2017, after tree cutting.
Source: Google Earth, "Notion Ancient City," imagery © 2026 Google, captured 2017, accessed April 22, 2026.



Figure 158. Satellite image of the theater at Notion, 2024. Source: Google Earth, "Notion Ancient City," imagery © 2026 Google, captured 2024, accessed April 22, 2026.

96. Giulia Caneva, La biologia vegetale per i beni culturali, Vol. I: Biodeterioramento e Conservazione (Fiesole: Nardini, 2001), 35.

Tree Age Analysis Mapping

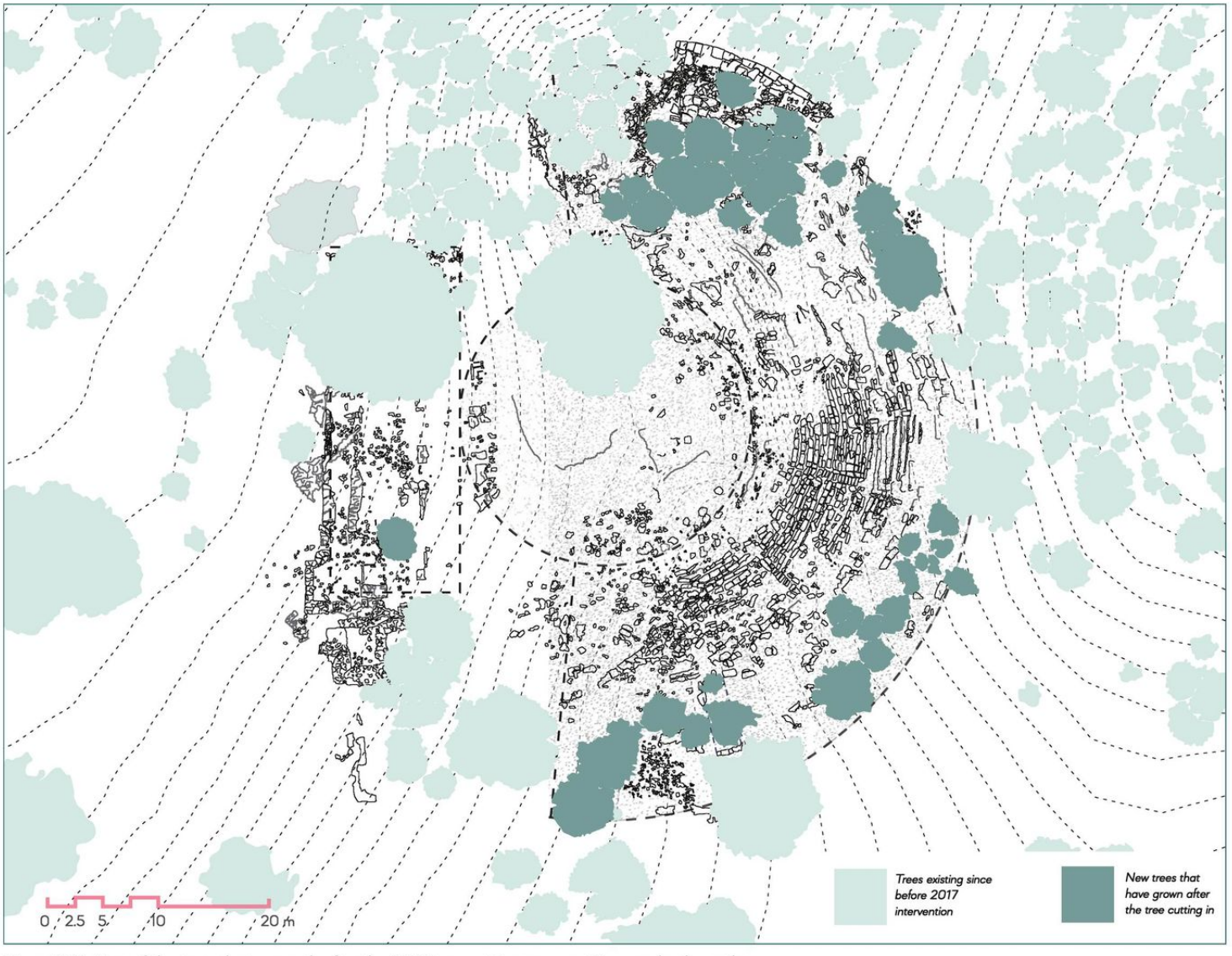


Figure 159. Map of the trees that regrowth after the 2017 tree cutting process. Diagram by the author.

The fact that this new growth is once again mostly pine and mastic, suggests preventative interventions used weren't effective. At present, as as we develop new intervention proposal for the vegetation in the theater's "cavea", it is crucial to take into account the age of the plants. Since the older and deeper roots eventually act as a " flexible connective issues" that holds the structure together, effectively becoming "consolidating vegetation"; the young trees have not yet developed these deep, thick woody root systems, so that dealing with them does not carry the same structural risks.[97]

97. Matteini and Ugolini, Il bisbiglio dei ricordi indefiniti,

06.

PATHOLOGIES AND INTERVENTION PROPOSALS ON THEATER

6.1 Main Pathologies in the Theater

The series of decays and interventions have been identified to address the pathologies encountered during the previous analysis of the theater. Considering the macro-areas that are already identified in the general analysis of the degradation pathologies, two zones were identified according to the climatic differences across the cavea, such as annual daylighting, as well as some human-induced degradations. However, in "Zone 2", moisture retention causes a high presence of biodeteriorating agents. The degradation evaluation of the overall theater (Fig. 160) analyzed both the North (Zone 1) and South Cavea (Zone 2). However, Zone 2 (Z2) represents "the worst-case scenario", exhibiting the most intense decay state within the site. While Zone 1 primarily represents natural aging and typical structural issues, Zone 2 suffers from the natural deterioration while additionally having anthropogenic damage that urgently requires intervention. Furthermore, its topographical orientation causes it to receive less sunlight and retain higher moisture, creating an ideal habitat for biological colonisation and insect activity. This microclimatic disadvantage has led to severe biochemical deterioration, such as microkarstification within the stone matrix.[98] This area represents a combination of active biological erosion and human-induced damage; therefore, it demands water-repellent applications, site management, and preventive conservation strategies. Ultimately, focusing the interventions on Zone 2, which encounters more severe and diverse problems, provides a comprehensive intervention protocol capable of addressing all potential decay scenarios throughout the theater.

98. UNI 11182:2006, Beni culturali. Materiali lapidei naturali ed artificiali. Descrizione della forma del degrado (Milano: UNI, 2006).

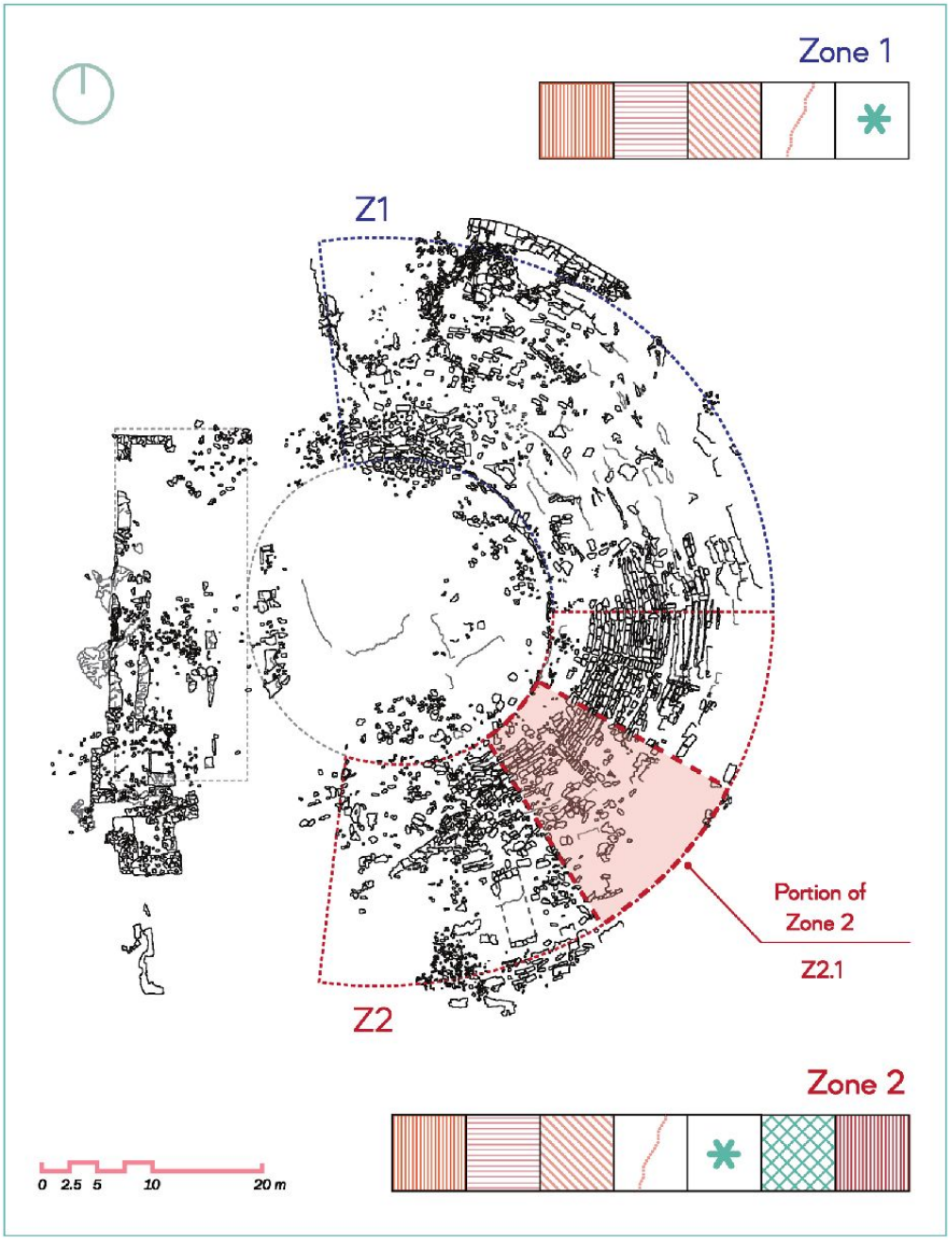
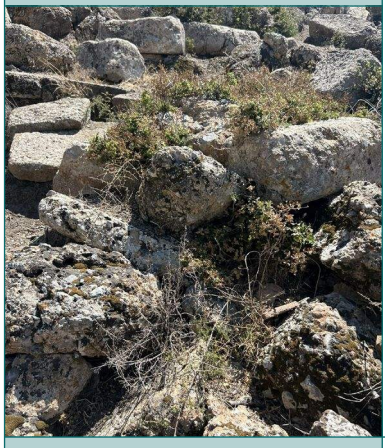
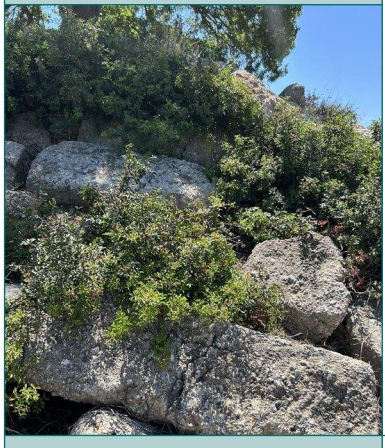
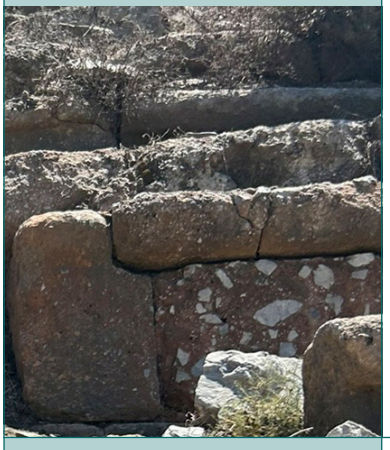
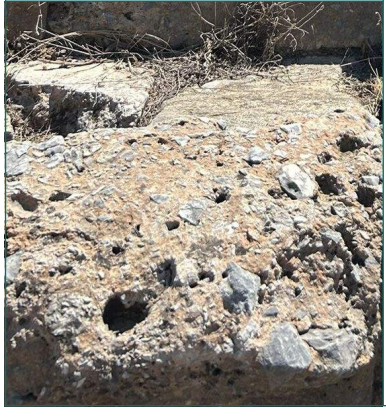


Figure 160. Map of the trees that regrowth after the 2017 tree cutting process. Diagram by the author.

Table of Pathologies

Patology	Definition based on Uni-Normal 11182:2006	Causes
Biological Colonisation 	Detectable presence of micro and/ or macro organisms (algae, fungi, lichens, mosses, higher plants).	High humidity levels, exposure to light (for photosynthesis), surface roughness, and the presence of organic deposits that provide nutrients for organisms.
Presence of Vegetation 	The presence of herbaceous, shrubby, or arboreal individuals. This refers specifically to the presence of higher plants (plants that have specialized tissues for conducting water and nutrients) rather than just microorganisms or mosses.	Over the centuries, the ancient seating stones have changed location and their structural integrity has been disrupted, but the natural soil between them has created a natural and fertile habitat, allowing vegetation to grow with sufficient sunlight.
Biological Patina 	The presence of herbaceous, shrubby, or arboreal individuals. This refers specifically to the presence of higher plants (plants that have specialized tissues for conducting water and nutrients) rather than just microorganisms or mosses.	Over the centuries, the ancient seating stones have changed location and their structural integrity has been disrupted, but the natural soil between them has created a natural and fertile habitat, allowing vegetation to grow with sufficient sunlight.

Patology	Definition based on Uni-Normal 11182:2006	Causes
Erosion 	Removal of material from the surface which, in most cases, remains compact.	The dominant winds coming from the sea to the ancient theater cause the stones to be exposed to marine aerosols.
Fracture 	Solution of continuity in the material that implies the mutual displacement of the parts.	Structural settling of the building, excessive loading, thermal expansion and contraction, or the physical wedging effect of growing plant roots.
Surface Deposit 	Accumulation of foreign materials of various kinds, such as dust, soil, guano, etc.. It has variable thickness and generally shows poor cohesion and poor adhesion to the underlying material.	The surface deposits in the site are caused by the dry deposition of natural pollutants, while the loss of detail is attributed to the collection of the waters.

Patology	Definition based on Uni-Normal 11182:2006	Causes
Vandalic Graffiti 	Unwanted application of colored paints on the surface. (UNI NorMal 11182:2006)	human action
Missing Parts 	Loss of three-dimensional elements (such as the arm of a statue, the handle of an amphora, or a portion of a relief decoration).	In conservation practice, missing parts usually result from direct mechanical impacts like vandalism or deep structural stresses. Environmental factors, such as frost action and expanding plant roots, also physically break the stone over time.
Perforation 	A single or series of surface punctures, holes or gaps, made by a sharp tool or created by an animal. The size is generally of millimetric to centrimetric scale. Perforations are deeper than wide, and penetrate into the body of the stone.	Stone perforations in the shaded areas is caused by the dominant moisture retention on the south cavea og the theater, which triggers two interacted decay mechanisms: biocorrosion (by insects and acid-secreting organisms) and chemical micro-karstification.

6.2 Mechanisms of Biodeterioration

It is interesting to examine deeply the zone of biodeterioration and the types of microflora present; however, these represent a characteristic element of the ancient theater's appearance. Thereby, it is sufficient to analyse the extent to which these microorganisms impact the conservation of the artefact.
From the point of view of degradation processes, the degradation mechanism can be divided into:

- Chemical degradation:
  Occurs due to chemical reactions between the material in use and reactive compounds originating from the natural or polluted atmosphere, which determine the production of reaction compounds (changes in the chemical composition of the material, leading to losses or alterations of the material).

- Physical degradation:
  Produced by physical phenomena, such as surface stresses caused by increases in volume of compounds contained in or in con tact with the material, or by thermal stresses.

- Biological Degradation:
  Produced by the action of biological species in contact with the substrate, and leading to chemical or physical alterations.

Anthropic causes could be added to these degradation and alteration processes of environmental-material interaction.

The biodeterioration phenomena of materials are closely related to both the chemical and chemical-physical nature of the substrate and the characteristics of the surrounding environment.

In other words, there is a complex system of interrelationships between organisms, materials, and the environment that allows us to figure out the genesis, dynamics, and peculiarities of the phenomena of material alteration; therefore, optimal strategies for preventing deterioration are also needed.[99]

Conglomerates are easily colonized by microorganisms due to both their high porosity and mineralogical composition; additionally, they have a tendency to absorb and retain moisture, which leads to high bioreceptivity.

99. ICOMOS-ISCS, "Illustrated Glossary on Stone Deterioration Patterns", Monuments and Sites XV (Paris: ICOMOS, 2008), 4–8.

6.2.1 Environmental Factors and Microclimate



Figure 161. Biological patina on the stone. Photograph by the author.



Figure 162. Biological patina on the stone. Photograph by the author.

Unlike the city center, the rural location of the ancient theater accelerates the biological deterioration of the stones. Trees and other plants create a special "microclimate" around the stones. The microclimatic features of the southern part of the theater, where bio-deterioration is more common, can be defined as follows:

- Lower sunlight exposure throughout the year;
- An increase in relative humidity;
- The mitigation of chemical pollution (chemical pollution is very low across the entire ancient city, which allows organisms to reproduce more easily compared to polluted urban areas);
- The effects of wind carrying seeds/spores;
- Increased shading;
- An increase in nutrients and eutrophication phenomena.

The microorganisms could cause the deterioration of the artifact stone, leading to the formation of a patina which lends a certain character to the ancient theater.[100] Biological patinas have been observed in the southern part of the theater's cavea that stands in the shadow and high moisture. Especially, in the study area, visible green biopatinas are present, which are predicted to be formed primarily by colonizations of cyanobacteria. Horizontal, porous, or moderately inclined surfaces are particularly suitable for the presence of birds, with a consequent accumulation of guano deposits. (Fig. 161-164)

The processes of alteration by biological organisms can be divided into:

- Physical Processes (leading to disintegration). These are due to the mechanical action of the growth systems of organisms (fungal hyphae, root systems).

- Chemical Processes (leading to changes in the chemical composition of the substrates).

100. Alois Riegl, 'The Modern Cult of Monuments,' Oppositions 25 (1982): 27–32.

Phenomenology of Biological Alterations

Tabella 2.1 - FENOMENOLOGIA DELLE ALTERAZIONI BIOLOGICHE

	Legno	Carta	Tessili	Pergamena, Cuoio	Materiali lapidei
Batteri autotrofi	nd	nd	nd	nd	croste nere, patine nere, esfoliazione, polverizzazione
Batteri eterotrofi	variazione delle caratteristiche meccaniche	macchie, variazione delle caratteristiche meccaniche (feltrosa e fragile)	macchie, cambiamenti di colore, perdita di resistenza	macchie, perdita di resistenza alla tensione, rammollimento	croste nere, patine nere, esfoliazione, cambiamenti di colore, macchie
Attinomiceti	idem	idem	idem	macchie, chiazze bianche, perdita di resistenza alla tensione	patine e e polvere bianco-grigiastre, efflorescenze bianche
Funghi	macchie, cambiamenti di colore, inteneri-mento, fessurazioni, cambiamento delle caratteristiche meccaniche	idem	macchie, cambiamenti di colore, perdita di resistenza	macchie, perdita di resistenza alla tensione, rigidità	macchie, esfoliazione, pitting
Cianobatteri e Alghe	patine di vario colore (soprattutto verdi)	nd	patine	nd	patine e pellicole di vario colore e consistenza

Figure 163. Phenomenology of biological alterations. Source: Caneva, Nugari, and Salvadori (1994).

segue Tabella 2.1 - FENOMENOLOGIA DELLE ALTERAZIONI BIOLOGICHE

	Legno	Carta	Tessili	Pergamena, Cuoio	Materiali lapidei
Licheni	incrostazioni, chiazze	nd	nd	nd	incrostazioni, chiazze, pitting
Muschi ed Epatiche	talli verdi-grigi	nd	nd	nd	talli verdi-grigi
Piante superiori	nd	nd	nd	nd	erba, arbusti e specie legnose inducono fratturazioni, collassamenti, distacco di materiale
Animali					
INSETTI	gallerie, buchi, rosume	abrasione superficiale, erosione, buchi, gallerie	erosione, buchi, perdita di materiale	erosione, buchi, perdita di materiale	buchi di forma tipica
PERFORANTI MARINI, LUMACHE	erosioni profonde, gallerie				
UCCELLI					deposizione di escrementi con effetto corrosivo buchi, scalfiture

Figure 164. Phenomenology of biological alterations. Source: Caneva, Nugari, and Salvadori (1994).

The degradation of lithic materials by biodeteriogens is therefore attributable to: Autotrophic organisms, which synthesize mineral substances from inorganic substrates, to transform them into organic matter:

- Algae (cyanobacteria, green algae);
- Chemosynthetic bacteria (Sulfur bacteria, Nitrite bacteria, Iron bacteria);
- Lichens;
- Mosses;
- Higher plants. Heterotrophic organisms, which directly use organic matter:
- Heterotrophic bacteria;
- Fungi.

6.2.2 Main Biodeteriogens in the Theater

When biodegradants find suitable habitats as mentioned above, they convert mineral substances on inorganic surfaces of stone materials into organic matter by synthesizing them. The degradation of lithic materials by biodeteriogens is therefore attributable to two main groups:
Autotrophic organisms (which synthesize mineral substances from inorganic substrates to transform them into organic matter):

- Algae (cyanobacteria, green algae);
- Chemosynthetic bacteria (sulfur bacteria, nitrite bacteria, iron bacteria);
- Lichens;
- Mosses;
- Higher vascular plants.
- Heterotrophic organisms (which directly use organic matter):
- Heterotrophic bacteria;
- Fungi.

Algae and Cyanobacteria

Algae need only light, water, and a few inorganic compounds to grow, and they thrive in alkaline environments (pH=7-8). Due to this reason, they are microorganisms that can be frequently encountered in conglomerate stones. Among these, greenish biological patina, indicating the probable presence of cyanobacteria, were observed in the theater during the field survey. Since these patina do not lead to material loss or disintegration in the theater, the algae growth could be characterized as an alteration rather than degradation.
Cyanobacteria are characterized by a thick and gelatinous coat that allows them to retain water and moisture for a long time. For this reason, they can survive also in the case of a lack of water. Depending on their interaction with the surface, they can be divided into different types. Epilithic (living on stone) algae are common types, and they form visible patina.[101] They adhere well to the underlying layer and appear in black-gray colors when exposed to strong sunlight. In poorly lit places, they can appear gelatinous and variable in color; they are usually green, orange, yellow, purple, or red, depending on their growth conditions. Materials with high porosity such as conglomerate create ideal conditions for water ingress and stagnation, encouraging the growth of pioneer microflora like algae, cyanobacteria, and mosses. In spite of possible deterioration caused by microorganisms, our study site primarily presents an "alteration" scenario.
Green biopatinas formed by these microorganisms do not yet cause significant structural and chemical degradation to the conglomerate stones. Instead, this phenomenon could be defined primarily as an aesthetic alteration rather than an aggressive biodeterioration. Furthermore, it is also possible that this dense mucilaginous layer of cyanobacteria acts as a "bioprotective" coating, buffering the stone surface against physical weathering factors such as wind erosion, water runoff, and thermal shocks.

101. Giulia Caneva, Maria Pia Nugari, and Ornella Salvadori, "Plant Biology for Cultural Heritage: Biodeterioration and Conservation" (Los Angeles: Getty Conservation Institute, 2008), 45–52



Figure 165. Lichens on the theater stone. Photograph by the author



Figure 166. Lichens on the theater stone. Photograph by the author

Lichens

A lichen is a symbiotic organism formed by the union of a fungus (heterotrophic organism) with a cyanobacterium or an alga (Figure 165, 166). The vegetative body or thallus has a characteristic structure for each lichen species and is divided into:

- Crustose: (compact and attached to the substrate), they penetrate the rock with their hyphae on the surface;
- Foliose: (having a leaf-like structure that is weakly attached to the substrate), they adhere with organs called rhizines;
- Fruticose: characterized by an upright and stalked thallus.

Lichen species can be primary or secondary colonizers. In the first case, they usually appear as crustose and foliose macroscopic structures with bright colors (white-yellow, green, black, or gray). In the second case, they develop simultaneously with algal layers and settle on them, appearing as a microscopic powder or a not very noticeable imperfect structure.

Regarding their impact on stones, the damage to stone materials can be physical (by keeping the substrate moist) or chemical. Chemical damage involves the production of metabolic acids that react with the substrate; for example, carbonic acid reacts with carbonates in calcareous substrates to form soluble bicarbonates. Other factors include lichen acids with a chelating effect and oxalic acids that lead to the formation of various oxalates. Hence, the role of lichens on stone surfaces can be complex and conflicting. Especially on porous stones like conglomerate, lichens can form a hydrophobic layer that repels water, thus performing an effective bio-protective function that protects the structure from environmental erosion.[102] Due to this dual nature, where they can cause biochemical decay while acting as a bio-protector in others, the decision to remove lichens from archaeological remains should be evaluated separately for each case. It is important to note that typical pitting decay was not actively observed at the ancient theater site.

102. Cozzolino et al., "The Role of Lichens, Mosses, and Vascular Plants," "Plants" 11, no. 24 (2022): 3429–3431.

Mosses (Bryophytes)

Mosses, along with liverworts, are non-vascular plants belonging to the bryophyte family. While they possess small structures resembling the stems and leaves of vascular plants, they lack the specialized tissues for water transmittance. Therefore, they anchor themselves to stone surfaces using root-like appendages named "rhizoids". Moss formations act as more than mere vegetation; they are "living archives" that record the passage of the monument through time. In coexistence with archaeological remains, mosses outline the spirit of the ruin, preserving its remembrance while keeping its aesthetic vitality, essentially acting as a living *patina* (Fig. 167). [103]

Archaeological sites with natural landscape contexts provide an ideal environment for these organisms, as they mainly prefer constant moisture. This is highly evident in the Notion ancient theater, where the conglomerate rock is structurally prone to absorbing water. The natural micro-cavities in the stone trap small amounts of humus (organic matter) necessary for the mosses' rhizoids to anchor. Considering these rhizoids have a weak adhesive capacity, they cause almost non-existent direct mechanical harm to the stone and can be easily removed from the rock surface. Remarkably, it should be noted that, unless they cover the delicate architectural details like cornices, bas-reliefs, or inscriptions, the cleaning of mosses is essentially an aesthetic preference rather than a technical necessity. Furthermore, thin layers of moss can sometimes have a beneficial conservation effect by acting as a hydrophobic (water-repellent) barrier that provides a "protective shield" against the direct erosive stresses of wind and rain. However, mosses do not always serve as a protective shield despite their beneficial qualities. They grow into green, dense, "spongy cushions" that are capable of holding up to 20 times their own weight in water when allowed to proliferate. As noted by conservation experts like Luigi Marino, this saturated microflora can act as a "lubricant" between stone layers. This lubricating effect may cause structural slipping or block displacement (slittamento) of blocks with existing structural problems or on sloping topographies. However, it should be mentioned that the cavea blocks of the Notion theater have not been actively detected to have such serious structural problems caused directly by mosses.



Figure 167. Mosses on the theater stone. Photograph by the author.

However, the most significant threat posed by mosses lies in their role as "pioneer species" within the process of ecological succession. Even though mosses by themselves may not cause much structural damage, they function as a trigger for further deterioration. As these spongy cushions develop on the surface, they progressively hold the detritus (soil and debris) transported by water and increase the nutrient levels on the stone. This accumulated organic detritus eventually forms a seedbed (incubation center), which encourages the germination and rooting of much more destructive, deep-rooted vascular plants (trees and shrubs), which eventually seriously damage the ruins mechanically.

The aging of mosses and vegetation can be accepted as an alteration rather than a degradation. However, if the presence of moss causes macroscopic material loss in the archaeological remains, such as detachments, crumbling, or erosion, it is then considered degradation, and at this point, intervention becomes necessary.

103. Matteini, 'La natura dei ruderi,' 50–51.

6.3 Interventions Strategies for Stone Deterioration and Biological Growth

6.3.1 Intervention of Erosion

The ruin's ageing should be respected therefore, the interventions are carried out for static purposes, not for aesthetic reasons.[104] In the site, the intervention should be implemented only to the conglomerate stones that have lost their matrix acting as a binder. However, intervention should only be made locally to critical points that have lost their binding property to the extent that they threaten the structural integrity or show advanced disintegration. Stones that are in good condition or only show minor superficial wear should be left untouched out of respect for their natural aging process.

Preconsolidation

Critical surfaces that will definitely undergo mechanical loss and crumbling during emergency intervention (cleaning etc.) are temporarily bandaged with pure cellulose Japanese Paper and low concentration (3-5%) Paraloid B-72 resin (velinatura). Thus, the principle of reversibility is maintained and material loss of the original material is prevented.

Cleaning

Using water is not preferred in order to avoid wearing down the stone surface. Free dust on the surface is dry-cleaned using solely soft-bristled brushes (e. g., badger hair) prior to consolidation.

Consolidation

A complete consolidation (completely sealing/freezing the stone surface) across the entire ruin is strictly avoided and should be evaluated case-by-case.[105] Only critical points that have lost their binder to the extent that they threaten structural integrity (Fig. 168), or show advanced crumbling/powdering, should be treated locally.

Since the primary material is conglomerate stone, the consolidant is chosen based on the stone's natural binding matrix. Where the matrix is calcareous (lime-based), limewater poultices are applied, ensuring that the calcium hydroxide is deeply and slowly absorbed into the capillary network of the stone. Conversely if the matrix is siliceous, a liquid consolidant called Ethyl Silicate is used to ensure chemical compatibility and proper internal strengthening.



Figure 168. Erosion on the vault stone. Photograph by the author.

Stones that are in good condition or show only minor superficial wear are left untouched out of respect for their natural aging process.[106]

Filling

Aesthetic filling is not operated in the whole archaeological remains, only "water trap" depressions that carry a freeze-thaw risk, salt crystallization and biological growth are filled slightly underflush using Natural Hydraulic Lime (NHL) to ensure avoiding the water collections on the stone surface.

Integration

Not applied.

Protection

Not applied.

104. Brandi, Teoria del Restauro, 29–35.
105. John Ashurst, Conservation of Ruins (Oxford: Elsevier Butterworth-Heinemann, 2007), 85–130.
106. Giovanni Carbonara, ed., Atlante del restauro architettonico (Turin: UTET, 2004), 215–260.

6.3.1 Intervention of Fractures

The fractures (Fig. 169), which have remained stable for centuries, are a dramatic visual feature of the ruin; they remain untouched.[107]

Preconsolidation

Only the sensitive cavea stone pieces that are about to break off/separate from the main mass are temporarily fixed (velinatura) using pure Japanese paper and low concentration (3-5%) Paraloid B-72 in order to prevent mechanical losses that may occur during cleaning or injection interventions.
However, the cracks that sit stably with their self-weight are not intervented in order to preserve the dramatic visuality of the ruin.

Cleaning

The inside of the cracks to be intervened is cleaned of dust/dirt with compressed air pumps and a little deionized water so that the injection mortar can hold.

Consolidation

Right before injecting the main injection mortar (PLM-A or Ledan) into the crack, the inner surfaces of the crack are locally moistened with a mixture of water and alcohol (or lime water) using a syringe.
Because the ancient stone that has been dry for centuries suddenly absorbs the water from the mortar like a sponge as soon as the liquid mortar enters. In other words, if the mortar dries out, it will dry out inside the stone, crumble, and be useless. By pre-wetting, it is ensured that the stone is saturated with water and, by using alcohol, the surface tension is reduced, guaranteeing that the mortar to be injected later will penetrate to the very bottom of the capillary crack.

Filling

Only cracks that pose a risk of water seeping in and causing capillary damage (icing/rooting) are injected with micronized natural hydraulic lime-based liquid injection mortars (e. g., PLM-A or Ledan series) that are fully compatible with the physical and chemical structure of the ruin and do not contain resoluble salts. The openings are then sealed with a compatible lime-based mortar. Synthetic resins and cement are strictly avoided.



Figure 169. Fractures on the theater stone. Photograph by the author.

Integration

No aesthetic, volumetric, or mass reintegration is performed on the ruin.[108]
In order not to disrupt the symbiotic balance that the ruin has established with time and nature, original cavea parts that have completely detached from the main mass are not reassembled in their original places using synthetic epoxies or titanium/carbon fiber pins (micro-imperniatura); therefore this process implies a 'definitive structural reinforcement' that goes against the natural flexibility of the structure. If broken or unstable blocks pose a serious safety risk on the pedestrian route, instead of mechanically fixing them by drilling into the monument, that part of the area is restricted from visitor access, or the broken pieces are removed to a safe location to be displayed next to the monument (following the lapidarium concept). The intervention is limited to sealing the cracks with water-repellent mortars rather than joining the stone.

Protection

The joints should be checked periodically for water ingress.

107. Brandi, Teoria del Restauro, 29–35.
108. ICOMOS, Venice Charter (1964), Articles 9, 12.

6.3.3 Intervention of Surface Deposit

As long as the soil and calcite crusts do not decay the stone, they are considered "patina of time" and left as they are.[109] The following conservation protocol reflects this principle, applying intervention only where biological or chemical deterioration actively threatens the structural integrity of the stone (Fig. 170):

Preconsolidation:
If a harmful crust needs to be removed and the underlying stone is very weak, temporary adhesion is provided by local silicate spraying.

Cleaning:
Only crusts that chemically/mechanically decay the stone or conceal an important inscription are removed with water mist (nebulization) or sepiolite clay compresses. Harmless, hardened natural soil crusts are not cleaned due to the aesthetics of the ruin.

Consolidation:
A consolidation process is absolutely not performed on the harmless natural crusts that are considered "patina of time" and left in place in the ruin, or on the entire stone surface. Intervention is only necessary if, after selective cleaning (nebulization or clay compress) is completed, erosion, crumbling, or mineral weakening is detected in the original stone tissue beneath the removed harmful crust. Intact tissues that emerge undamaged from cleaning are left untouched. The mineral tissue of the stone is supported by applying local lime water compresses (impacchi di acqua di calce) to weakened specific areas to allow calcium hydroxide to slowly and deeply penetrate the capillary spaces of the stone and to prevent the formation of an unwanted white haze on the surface.

Filling:
Micro-filling is done in the deep cavities that appear after cleaning. To prevent water retention in the deep cavities that appear after cleaning in winter, they are filled with breathable micro-mortars obtained from a mixture of salt-free lime paste (grassello di calce) and micronized marble powder / finely sifted compatible stone powder. The process is carried out using dental spatulas (dental instruments), leaving a very slight gap (sotto-squadro) so as not to cover the original surface of the stone. Synthetic pastes or cement are absolutely not used.



Figure 170. Deposit on the theater stones. Photograph by the author.

Integration:
Not applied

Protection:
Synthetic chemical films that make the ruin suffocating are avoided; it is left in its natural state.

109. Brandi, Teoria del Restauro, 51–60.

6.3.4 Intervention of Vandalic Graffiti

Graffiti on an archaeological remains (Fig. 171) cannot be seen as part of the aesthetics of ruins and should therefore absolutely be removed.

Preconsolidation:
Not applied

Cleaning:
This process is the preliminary intervention throughout the steps. Attempting to remove paint by scrubbing with thinner will only cause the paint to penetrate deeper into the pores. The primary objective of this intervention step is to vaporize the paint using a universally standardized Nd:YAG laser and remove it from the stone without physical contact.
However, in situations where laser application is not possible, specially formulated "Organic Solvent Gels" or environmentally friendly "Green Solvents" designed to dissolve modern synthetic paints are applied as a paste using paper pulp/cellulose to ensure controlled removal of the paint from the surface.

Consolidation:
After the cleaning process (Nd:YAG laser or green solvent gels) is complete, a general application of consolidation chemicals should absolutely be avoided without a detailed damage inspection of the entire stone surface. Consolidation should only be performed if local binder loss and textural weakening are detected on the local stone surface. In this case, the consolidation intervention depends on the natural structural composition of the conglomarate stone matrix. If the conglomerate stone matrix is calcareous, lime water compresses (impacchi di acqua di calce) are applied; this method prevents the liquid from evaporating and leaving an undesirable white pus (sbiancamento) on the surface. If the matrix is siliceous, a liquid consolidation agent called ethyl silicate is used to ensure chemical compatibility and repair the weakened mineral structure. Furthermore, stones that are undamaged after cleaning should absolutely not be touched.

Filling:
Not applied.



Figure 171. Graffiti on the ancient stones. Photograph by the author.

Integration:
Not applied.

Protection
Synthetic "anti-graffiti" varnishes or transparent polishes that form a film on the surface to protect the stone against vandalism are strictly prohibited. Such chemicals prevent the stone from breathing through water vapor, triggering freeze-thaw and salt erosion (subflorescence); moreover they also plasticize and spoil the matte and natural landscape aesthetic (*genius loci*) of the ruin. In this type of deterioration, the conservation step is not to intervene with the stone, but also manage the area. As part of a conservation strategy, the object is to increase the physical security of the area with barriers in the site or deterrent systems compatible with the landscape (preventive conservation) and to carry out regular periodic monitoring (Programmatic Maintenance) for the early detection of possible new graffiti formations before the paint polymerizes (before it fully penetrates the pores of the stone).

6.3.5 Intervention of Perforation

During the site visit, it is observed a significant quantitative difference in the perforation and pore formations between the south and north cavea of the theater (Fig. 172, 173). The stones in the south part Z2 are exposed less sunlight annually which leads to have higher amount of perforation accompanied by the dense biological colonization (e. g. mosses)have capability of high moisture retention capacity; whereas the north cavea which receives more sunlight annually, exhibits remarkably less perforation.

This difference between caveas can be explained with the microclimatic differences between two zones (Z1 and Z2), specifically due to the moisture retention, which could be triggered by:

Biochemical Decay and Insect Activity:
The coastal location of the ancient city subjects its archaeological remains to a constant salt laden marine aerosols and moistures.
The shaded environment of the south cavea retains moisture for the long term, which is a very compatible habitat for the biological colonizers. The metabolic activities of these organisms on the stone, chemically erodes the surface of the stones and creates the small cavities. Furthermore, the humid and biologically rich habitat attracts the various lithophagous (stone-boring) insects. The insects bore the weak conglomerate matrix in order to build the nests or seek shelter; thereby enlarging the small cavities into visible perforations.

Water Induced Chemical Decay and Dissolution of the Stones:
The long-term presence of the water and moisture on the stone surfaces on the south cavea, accelerates the dissolution of the calcium carbonate matrix of conglomerate. This causes transformation of micro pores into visible perforations.
By contrast, the north cavea is subjected to more annual sunlight, thereby the rapid evaporation of the water /humidity on the surfaces reduces the chemical dissolution, and avoids growing of the acid-secreting biological colonies, resulting in a remarkably lower incidence stone perforation.



Figure 172. Perforations on the theater stone. Photograph by the author.

Cleaning:
Biocidal Treatment: Before the physical cleaning, biocidal agents can be implemented into pores and insect perforations in order to devitalize the active microflora (lichens and fungi) that often co-habit these micro-cavities.

Manual Mechanical Removal & Dry Cleaning:
After the biocidal treatment, the residues of insect nest, mud and colonies must be gently removed by non-metallic spatulas (wood/teflon) and soft bristled brushes to avoid damaging the weakened conglomerate matrix.

Consolidation:
Impregnation: Since the binder matrix of the stone is dissolved due to the biological acids and the microkarstification and reducing its cohesion, the stone should be impregnated with breathable consolidants such as Ethyl Silicate or nano-lime. Thereby, the internal mineral network is recreated without obstructing the pores.



Figure 173. Perforations on the theater stone. Photograph by the author.

Filling/Painting:

Under-flush Micropointing: After the consolidation of the cavities, the accumulation of the water and formation of new insect nest must be avoided. The material choice for filling the cavities is breathable Natural Hydraulic Lime (NHL) micro-mortars which should be applied with an under-flush (sotto-squadro) technique. With this approach, the filling is distinguishable from the stone's conglomerate material.

Integration:
Not Applied.

Protection:
Water Repellent Protection: Due to the high moisture retention on the south cavea, it is essential to avoid these surfaces from water. The localized application of "siloxane-based water-repellent preventive coating" is recommended. This application helps to avoid the regeneration of the biological colonization and microkarstification while permitting a breathable surface.

Programmed Maintenance:
The surface dust and soil accumulation should be swept away periodically to prevent seedbed formation.[110]

Monitoring :
Annual visual inspections should be conducted to verify conservation status of the previously applied NHL fillings.

110. Roberto Cecchi and Paolo Gasparoli, Prevenzione e manutenzione per i beni culturali edificati: procedimenti scientifici per lo sviluppo delle attività ispettive: il caso studio delle aree archeologiche di Roma e Ostia Antica (Florence: Alinea, 2010), 15–65.

6.3.6 Intervention of Biological Patina

Intervention of Lichens

Lichens are symbiotic life forms of fungi and algae. The lichens could adhere very tightly to the stone and excretes oxalic acid. The mentioned acid chemically dissolves conglomerate stone and as a consequence it can create craters on the stone surface (Fig. 174, 175). Nevertheless, lichens aren't always enemies that need to be eradicated. Scientific literature has proven that lichens can also act as a "biological shield (bioprotection/umbrella effect)" by producing calcium oxalate patinas, protecting the stone from the dissolving effects of water, wind erosion, and thermal shocks. Therefore, the current philosophy is not the automatic elimination of lichens; rather, the aesthetic and physical damage they cause, and the protection they provide, should be evaluated on a case-by-case basis to decide whether or not to intervene.



Figure 174. Lichens on the theater stone. Photograph by the author.

Preconsolidation

If the stone texture under the lichen has been crumbled/broke into pieces due to acid exerted by lichens, the local bandaging may be applied only to the weak stones around the lichen, very rarely, to avoid dislodging the stones during cleaning. If the conglomerate matrix is severely weakened, in addition to bandaging, ethyl silicate (silicato d'etile) can be injected locally through slow needle irrigations into the loosened tissues, and bandaging can be applied using Paraloid B-72 in a low concentration (3-5%). The reason for these applications is to prevent the irreversible loss of the original matrix and clasts (pebbles) under the physical stress that cleaning procedures (brushing, water contact) will create in the stone, and to hold the stone together securely, even temporarily.

Cleaning&Biocidal Stage

Chemical cleaning should be operated initially, then mechanical cleaning should be followed. Live lichen should never be dry-brushed as this can cause the stone to break into pieces and spread the spores. Preventol RI 80 (Quaternary Ammonium) or optionally proteolytic enzymes (such as trypsin in borate buffer at pH 8.2 are sprayed onto the lichen layer. It takes 30 minutes for the lichen to die and lose its ability to adhere to the stones (turn black). Dead colonies are washed away by gently scraping them off the stones with deionized water and wooden/plastic spatulas.

The following intervention strategy based on case-by-case analysis; the intervention should be only carried out on lichen colonies that are found to be actively eroding the stone or impairing the readability of the ruin. Live lichen colonies are never dry-brushed; This process increases colonization by spreading fungal spores (reproductive cells) to the area and causes the hyphae, which are firmly attached to the stone, to detach, also removing the original mineral tissue.

Cleaning is carried out in two stages in accordance with universal conservation standards:

Biocidal Stage:

A biocide that does not leave harmful salt residue on the stone is applied to the lichens analyzed as damaging the stone. The chosen biocide acts on lichens without releasing nitrogen into the rock, thus avoiding further algal growth and not creating a food chain in the residue. For this reason, isothiazolinone-based biocides (e. g., Biotin T), applied at a concentration of 1-3%, are recommended.[111] Moreover the biocide is diluted strictly with deionized water (to prevent introducing new soluble salts into the stone) in order to ensure environmental safety and material compatibility. It is applied carefully to the affected areas using low-pressure spraying or soft brushing, taking necessary precautions so as not to harm the surrounding soil and ecological system in which the ruin is located.

After this process, the chemical is left to sit for 10-15 days to allow the colony to undergo necrosis (turn black) and lose its resistance to adhering to the stone. After this period, the "mechanical phase" begins.

Mechanical Step

Dead colonies that have undergone necrosis (lost their adhesion) are gently scraped off the surface using plenty of deionized water and wooden/Teflon spatulas that will not scratch the stone. Remaining organic debris is washed away with soft-bristled brushes to complete the cleaning process. Metal tools must not be used.

Consolidation

The underlying texture of the stone, which has been eroded and weakened by the acid of the lichen, is is consolidated using ethyl silicate (silicato d'etile) applied by brush or low-pressure spraying to deeply restore the cohesion of the mineral matrix without altering its breathability.

Micro-Filling

The crater-like cavities created by the lichens in the stone should be locally micro-filled, flush with the surface, to prevent water from filling and freezing in low temperature periods of the winter. For this purpose, instead of hard/impermeable chemicals like cement or epoxy that will crack the stone from the inside, they are filled with Natural Hydraulic Lime (NHL 3.5) and aggregates (small pebbles/sand) selected to match the texture



Figure 175. Lichens on the theater stone. Photograph by the author.

of the original stone. NHL 3.5 is preferred because its mechanical compatibility with the historical stone texture has been proven, it does not contain soluble salts, and it allows the moisture inside to evaporate (allowing the stone to breathe).

Integration

Not applicable.

Protection

Lichens thrive in moist and acidic environments. In order to avoid the reformation/recolonization of lichens, the water/moisture absorption capacity of the conglomerate's specific horizontal surfaces must be reduced. Silane/siloxane-based water repellents should be applied to the surface until saturation is reached. The main reason to choose these materials is that, considering their molecular structure, they do not seal the pores like a plastic film, while allowing a high degree of water vapor to escape from within the stone, which is called breathability.[112] Through this application, it keeps liquid rainwater out, thus completely eliminating the wet environment necessary for lichen survival and sporulation without suffocating the entire ruin.

111. Marino, Il restauro archeologico, 89–94.
112. Marino, Il restauro archeologico, 76–82.; ICOMOS-ISCS, Illustrated Glossary on Stone Deterioration Patterns.

6.3.7 Intervention of Mosses

Mosses are rootless plants; mosses do not release aggressive acid onto the stone comparable to lichens (Fig. 176). However, they cause severe physical deterioration through freeze-thaw cycles and keep the stone continuously wet by creating "spongy cushions" that may hold up to 20 times their own weight in water. However, thin layers of moss that do not harm the stone and have a low Hazard Index (IP 0-3) are left untouched as the spirit of the ruin (*patina*). This selective preservation shows what Riegl defines as age value, the marks of time that adds value to ruins' authentic character.[113] Conversely, the intervention is strictly required when the moss layer becomes excessively thick and accumulates soil/humus layer (substrate) where medium hazard (IP 4-10) shrubs and trees can be rooted. The main intervention object is to avoid settling of new high hazard vegetation formation on the remains, while breaking the chain of ecological succession and interrupting the cycle in order to eliminate the think and wet moss seedbed.



Figure 176. Mosses on the theater stone. Photograph by the author.

Preconsolidation

Not applied.

Cleaning

Unlike lichens, chemical treatments are not primarily recommended for cleaning mosses. Thick layers of moss with the thick layer of soil underneath, should be scraped off the stone using wooden spatulas. The remaining fine residue can be swept away with a soft-bristled brush and washed with water. If stubborn root-like extensions (rhizoids) must be removed, biocides (e. g., Biotin T) can be utilized locally.

Consolidation

The moisture in the stone due to the moss can create the freeze-thaw cycles, leading to erosion on the underlying layer of the stone. In this situation, local consolidation can be performed using lime water and ethyl silicate (depending on the specific matrix). These specific consolidants are chosen because they penetrate deeply and recreate the stone's natural mineral network without blocking its pores. This approach restores the stone's internal cohesion while preserving its water vapor permeability (allowing the stone to "breathe"), which is crucial to prevent further freeze-thaw damage.

Filling

The most critical location of mosses on the stones are the deep joints and pre-existing open cracks. The soil accumulations due to the wind and rain in the deep cracks, mosses then could trap the water within these cracks, acting as a water trap and seedbed for other high IP vegetations. In order to avoid these risks, the deep joints exposed after the moss is removed should be filled with Natural Hydraulic Lime (NHL) mortar, applied slightly under flash (using the sotto squadro tecnique).

Protection (Preventive Conservation)

The moss formations placed on a steep surface that cant retain the water inside and have an IP between 0-3 hazard level, should be preserved as they are, preserving them as a part of the ruin's natural beauty.

Programmed Maintenance

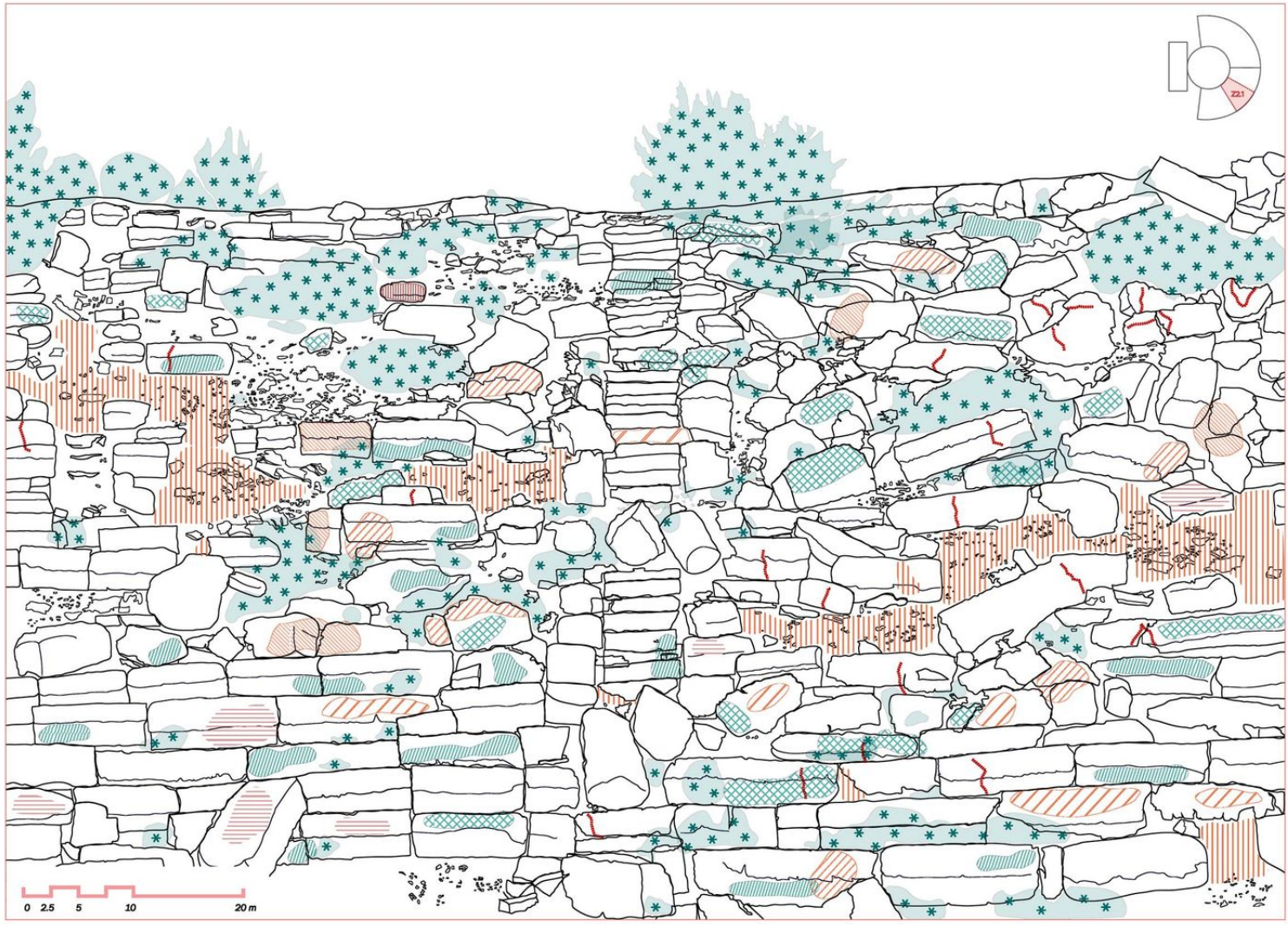
In order to prevent thick cushions and to stop them from preparing a fertile substrate for dangerous IP level woody plants, the soil accumulation on the stones should be regularly swept away because the moss requires dust and soil on the stone to reach a destructive extent.

Integration

Not applied.

113. Riegl, 'The Modern Cult of Monuments,' 21–27.

6.4 Mapping of Pathologies and Intervention on the Selected Elevation







Z2.1

Figure 177. Degradation mapping on the selected theater elevation, with key plan and panorama (drawing at above); panoramic photograph showing selected portion for investigation (on the left) and selected portion photograph (on the right), by the author.

Intervention Table (UNI/NORMAL Standard)

Terminology follows the guidelines established ICOMOS ISCS and Italian UNI/NORMAL Standards (UNI 11119 /UNI 11121).

Preliminary Assessment

IP ≥7

High Hazard Index
According to Signorini's IP index, the intervention should be prioritized high hazard plants and evaluated case by case.

Case by Case Evaluation
Detailed analysis is required to develop intervention strategies in case studies.

Biocidal Treatment

Biocidal Treatment
Applying specific chemical or ecological agents (e.g., salt-free Biotin T) to devitalize active biological colonizations by inducing necrosis prior to physical removal.

Filling&Injection

Under-flush Micro-pointing
Applying breathable Natural Hydraulic Lime (NHL) micro-mortars slightly below the original stone profile to prevent water pooling while respecting the historical patina.

Deep Grouting / Injection
Applying specific chemical or ecological agents (e.g., salt-free Biotin T) to devitalize active biological colonizations by inducing necrosis prior to physical removal.

Preconsolidation

Temporary Bandaging
Securing fragile pieces at risk of crumbling prior to cleaning using pure cellulose Japanese paper and low-concentration (3-5%) Paraloid B-72 (Velinatura).

Temporary Adhesion
Applying local silicate spray to temporarily secure severely weakened stone tissues beneath harmful crusts during cleaning.

Consolidation

Impregnation
Applying compatible consolidants (limewater poultices or Ethyl Silicate) to deeply penetrate and recreate the mineral network of weakened tissues without altering breathability.

Surface Pre-wetting
Wetting the inner surfaces of cracks with a water-alcohol mixture prior to injection to reduce surface tension and prevent premature drying of the mortar.

Maintanence

Water-Repellent Protective
Applying silane/siloxane-based water repellents until saturation to eliminate the wet environment required for biological colonization, maintaining breathability.

Programmed Maintenance
According to Signorini's IP index, the intervention should be prioritized high hazard plants and evaluated case by case.

Cleaning

Dry Cleaning (air pumps-aspirations)
Removing loose dust and debris from deep fractures and fragile surfaces using low-pressure micro-compressors or delicate vacuum devices without physical contact.

Dry Cleaning(soft-bristled brushes)
Removing loose superficial dust using soft-bristled brushes without scratching or wetting the stone surface.

Aqueous Cleaning
Dissolving harmful crusts gently without mechanical friction using water mist (nebulization) or absorptive sepiolite clay poultices (impacchi).

Chemical & Laser Ablation
Removing modern synthetic paints using Nd:YAG laser technology or environmentally friendly organic solvent gels.

Manual Mechanical Removal
Mechanically removing thick moss cushions and soil substrates using non-metallic hand tools (wooden/Teflon spatulas), followed by dry brushing.

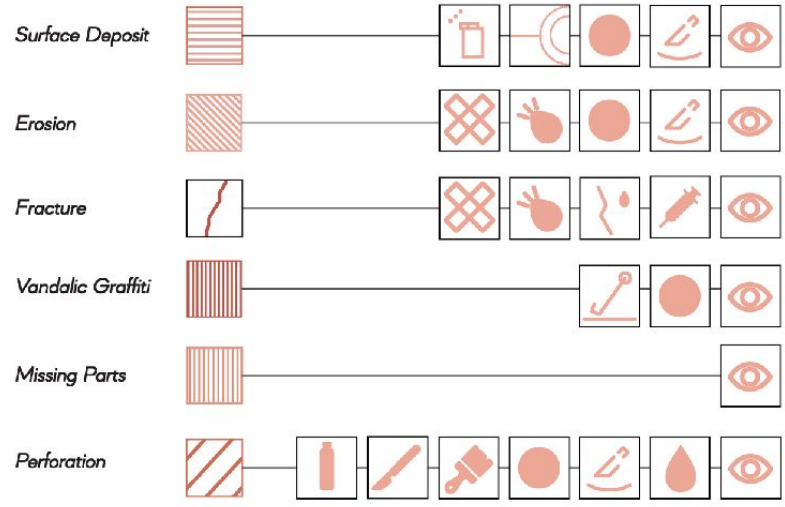
Legend

Presence of Vegetation

Biological Colonisation

Biological Patina

The intervention proposals will be evaluated case by case.



6.5 Intervention Strategies on Vegetation

6.5.1 Methodological Approach to Vegetation Management

As in the theoretical framework established in Chapter 5, the ultimate risk posed by the vegetation is a product of the plant's intrinsic hazard (IP) and the vulnerability of the stone. Since the entire cavea and the retaining walls are constructed of porous conglomerate stone, the bioreceptivity regarding material is consistently high across the entire theater. For this reason, the Hazard Index (IP) served as the primary decisive criterion during the decision-making process for the interventions.

In the decision-making process for managing vegetation on an archaeological site, one of the primary criteria considered is the IP values of the species. Once the shrub-form plants and their IP indices are evaluated, their spatial relationships and proximity to the remains must be considered to analyze the potential decay that can occur on the cavea stones. Therefore, the intervention strategies should be evaluated on a case-by-case basis.

While the approach of IP assessment of Signorini defines quantitatively the mechanical and biological hazard of the plants, modern archeological conservation frameworks highlight the significance of aesthetic value, ecological role, and abundance of the shrub-form plants regarding to determine the intervention strategy. Shrub forms with an IP value between 4 and 6 are generally classified as posing a "moderate danger" because of their deep-rooting and sprouting capacities.

The intervention strategies proposed in this study are fundamentally guided by the advanced archaeobotanical and conservation methodologies established by scholars Giulia Caneva and Maria Antonietta Signorini.[114] According to this multidisciplinary approach, the intervention decisions, such as eliminating, pruning or maintaining a plant-are not only determined by the numerical hazard index (IP), but rather by balancing the preservation of the ruins with the ecological and aesthetic values of the landscape.

The final intervention proposal for each shrub and plant species should be determined also with evaluating the following critical site-specific parameters:

- The abundance of the species in the area,
- The aesthetic and environmental value of the plant,
- The physical condition and fragility of the archaeological remains on which the plant is situated.

By integrating these parameters, the methodology ensures an appropriate conservation strategy that maintains the structural integrity of the remains while respecting the *genius loci* (spirit of the place) and the natural landscape of the archaeological ruin.

The intervention proposals for the vegetation are determined by this decision matrix, as follows:

- If the shrub has high IP with low aesthetical value, as Lentisc can be eliminated;
- If the shrub has low IP with high aesthetical value, as thyme and rosemary in the site, preservation and maintenance should be implemented.
- If the shrub has a moderate IP (4-6) and high aesthetic value, the direct elimination decision should be avoided, instead mitigation/ controlled management is suggested for these plants.

During the decision-making process, selective interventions are implemented for shrub forms with an IP of 4–6. If the root acts as a support to the structure, it should be preserved and treated as a consolidation of the cavea's topography. Concurrently, if the plant has grown on a highly deteriorated part of the monument, uprooting it could cause greater damage to the monument's structure. This is because the root of the shrub might function as "flexible connective tissue" that holds the stones together. Uprooting or extracting the roots could lead to a collapse or cause severe deterioration of the material integrity. Therefore if the roots function as a consolidating element, should stay in-situ and be remained to support the cavea's topography. The intervention proposal for the vegetation should be improved on its specific cases, following a periodic maintenance phase.

114. Caneva, La biologia vegetale per i beni culturali, 35–40.; Signorini, "L'Indice di Pericolosità," 7–14.

6.5.2 Methods of Intervention

With reference to the analyses carried out on the entire plant species of the ancient theater, in particular the investigations conducted for each species to identify their risk to the masonry structure, an intervention procedure for the vegetation was sought that took into account the danger of each individual species, as well as the aesthetic and characteristic value they add to the archaeological site. The interventions concerning the entire plant structure of the amphitheater can be summarised into four distinct categories, which are reported below.

Maintenance

Maintenance operations must be performed periodically on all plant species, regardless of the specific treatment indicated, to ensure optimal health and prevent potential damage to the structures. The maintenance involves routine tasks, such as shrub trimming and cutting to prevent uncontrolled growth. Generally, the maintenance procedure is applied to subshrubs and plants with a low to moderate hazard index (0-3) that do not possess highly intrusive/robust taproots, such as Thyme, Oregano, and Rosemary at the current site.

Monitoring

Monitoring is an observe-and-study operation for the species without an excessively high IP index. It can be also carried out for the plants that do not have an interaction/contact with ancient remains. The main purpose is to document the growth of the plant, or overall density in the area. Monitoring should guide the decision to act for possible future interventions, especially in cases of worsening conditions or critical interactions between the plants and ruins over time.

Pruning

In ancient theaters and similar sensitive archaeological areas, 'pruning' (containment pruning) has been chosen as the primary intervention method for shrub species with a relatively moderate hazard index (IP) (between 4-6) but whose direct removal would cause damage to the site (for example, Bay Laurel and Spanish Broom). This methodology aims to prevent the damage the plant could cause to the structure by triggering its natural growth behaviour instead of eradicating it.

The application of the following methodology aims at:

Decreasing the wind pressure and avoiding root spread : Pruning reduces the plant's crown volume, thereby decreasing wind pressure on the canopy. By reducing the wind load, the plant no longer needs to expand and deepen its roots to maintain its mechanical stability.

Prevention of Aggressive Growth Reactions and Leverage Effect: Especially in species like laurel, completely cutting the trunk or severe topping triggers its survival reaction, leading to much more aggressive suckering. Gradual and selective crown pruning avoids this dangerous reaction by controlling the plant's volume without stressing it.

Physiological Control (Switching to Protection Mode):Pruning reduces the density of the leaf, which decreases the photosynthetic potential and stored energy of the plant. This situation shifts the plant from an "active growth and spread" mode to a "controlled and maintained" stage, slowing down its root expansion.

Consolidating Effect of Roots: In some cases, plant roots act as a "flexible connective tissue" that holds stones together in a highly deteriorated cavea stone structure. Since the removal of such plants could cause sudden collapses (cavity failures), the pruning method ensures that the plant's root system remains as an in-situ consolidation element.

Elimination

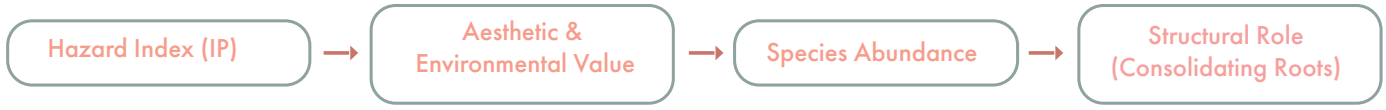
Elimination is applied to the species with a high-danger species (IP 7-10) and highly recommended for the moderate-danger shrub species (IP 4-6) when they have intrusive taproots and lack significant aesthetic or cultural value. As highlighted in the case-by-case evaluations, while the aesthetic species in the moderate danger category are managed through pruning, the invasive shrubs posing direct mechanical threats as Sarcopoterium spinosum or Arbutus andrachne, require complete eradication strategies. Therefore, the elimination decision must never be taken without a case-by-case evaluation for the vegetation within the moderate danger category. Due to the shrubs' intrusive taproots, the elimination procedure mainly consists of a "cut and treat" strategy (for woody species), as manual uprooting would severely damage the existing archaeological soil layer or fragile stone structures. Two options for the herbicides used on the site are proposed, which are Triclopyr and Glyphosate. Historically, classic Italian restoration literature and traditional European monument conservation guidelines have frequently addressed Glyphosate as the primary systemic herbicide, and it has been utilized for decades. However, there are currently ongoing debates within the European Union regarding the use of Glyphosate due to its intense environmental impacts. In accordance with EU Directives (such as 2009/128/EC), the widespread aerial or foliar spraying of Glyphosate in public parks and historical sites is strictly regulated; nevertheless, the highly localized "cut-and-treat" (brush) application of systemic herbicides is legally approved within these restrictions. [115] Given the ongoing discussions concerning Glyphosate, the use of Triclopyr should be evaluated as a viable alternative for the "cut-and-treat" process.

In archaeological vegetation management, the primary objective of any chemical intervention is to minimize environmental impact and prevent secondary chemical damage to the historic stone fabric. Therefore, utilizing a highly localized herbicide application method (such as cut-and-treat) becomes as crucial as the choice of the chemical agent itself in reducing ecological risks. Instead of widespread spraying which risks uncontrollable chemical dispersion, the herbicide must be applied strictly and locally to the active cambium layer of a freshly cut stump. This localized zero-drift approach ensures the complete devitalization of the woody root system while avoiding the spreading of toxic agents, thereby acting in full compliance with European environmental protection regulations. The localized application of systemic herbicides prevents aggressive regeneration and causes the intrusive roots to decay slowly. As a result of this slow decomposition, structural cavities within the stone and voids in the soil base may emerge over time, which will subsequently require structural consolidation.

115. Fabbri, Catalano, and Ugolini, 'Vegetation in Archaeological Areas,' 2716–2717. The authors confirm that localized "cut-and-treat" application is the accepted methodology within EU Directive 2009/128/EC regulations for sensitive heritage areas

6.6 Intervention Strategies By Species For Shrubs

1 Methodologies Framework for Shrub & Subshrubs



2 Decision-making Process for the Intervention Strategies

Low IP + High Aesthetic → Preserve & Maintain.

High IP + Low Aesthetic → Eliminate (Cut-and-Treat).

Moderate IP (4-6) → Case-by-case evaluation (Mitigate / Prune).

3 Interventions

Controlled Maintenance: For IP 0-3 (e. g., Thyme). Aerial cutting to reduce moisture retention.

Containment Pruning: For IP 4-6. Reduces "sail effect" and limits root spread without eradication.

Targeted Elimination: Chemical devitalization (cut-and-treat) to avoid mechanical shock from manual uprooting.

6.6.1 Bay Laurel

Analysis

Bay Laurel is considered "moderately dangerous" due to its IP of 6. Nevertheless, considering its rarity on the site and its subjective aesthetic significance, elimination/ complete eradication is not considered an appropriate intervention. Furthermore, Bay Laurel exhibits a suckering habit, therefore cutting it might trigger more aggressive regrowth. Additionally, the characteristic of the root system is indicated as "slightly taproot" in the IP index analysis. This refers to the root system has expanded in the soil or is interacting with the theater remains.

- Hazard Index (IP): 6 (Moderate Danger)
- Root System: Slightly Taproot / Intrusive
- Invasiveness: Suckering Shrub
- Aesthetic Value: 2/3 (Moderate-High)
- Abundance: Very rare (Only 1 specimen on the site)

Intervention

Containment pruning could change the natural behaviour of the plant to a preserving state, where the root expansion is prevented, both by reducing the need of resistance to the wind and the amount of photosynthesis for growth. Keeping the current root system might help the soil resistance in the bay laurel's position on the top of the cavea, and would prevent the possible damage during the uprooting process.

Monitoring should be done after the pruning, observing the state of the shrubs' growth, and if necessary, further pruning can be applied.

Contingency Intervention:
If future excavations are required at the plant's location, "cut and treat" process must be operated. The bay laurel should be cut at the base and treated with a triclopyr-based herbicide; over time, the decayed roots must be uprooted to facilitate the excavation.



Figure 178. Bay laurel (Laurus nobilis). Photograph by the author

6.6.2 Lentisk/Mastic Tree

Analysis

Lentisk is among the most abundant woody species in the cavea. It has a robust root system and demonstrates a high capacity for vegetative regeneration (stump sprouting). This biological trait is evident from the observation that the lentisk shrubs cut during the 2017 cutting operation have vigorously resprouted, rapidly replacing the cut stems with dense new shoots from the remaining stumps. From an aesthetic and spatial perspective, the dense growth of the lentisk visually covers the archaeological remains, not adding a significant aesthetic value to the seating blocks. Furthermore, the microclimate created by its dense, evergreen canopy retains continuous moisture on the shaded stone surfaces, which could create the ideal conditions for the biological colonization.
Conversely, an aggressive effort to complete uprooting of the mature lentisk could cause structural failure. Over the decades, their extensive root systems have deeply penetrated the cracks of the seating blocks, effectively acting as a "consolidating connective tissue" (or consolidating vegetation) that holds the fragile dry-stone structures together in their current configuration.

- Hazard Index (IP): 6 (Moderate Danger)
- Root System: Robust Taproot and highly intrusive
- Invasiveness: Suckering Shrub (High resprouting capacity)
- Aesthetic Value:1/3 (Low)
- Abundance: Highly abundant (Many specimens in the area)

The intervention process for these specific cases must be evaluated on a case-by-case basis, carefully balancing the biological risks of the vegetation against the structural fragility of the ruins it currently consolidates.

The intervention should be executed in the following steps:

Selective Elimination

If the lentisks does not act as "consolidating vegetation" but if it causes separating the stones from each other and increasing the static risk; they must be eliminated with a "cut-and-treat" strategy. Once the mechanical integrity of the stone is ensured or if the shrub must be removed strictly, the elimination procedure begins. Manual uprooting must be avoided as pulling the roots could cause damage to the stone structures. Therefore, the shrub must be cut at the base, and immediately, a compatible application of a triclopyr-based herbicide must be applied immediately to the surface of the cut stump to prevent resprouting. This application helps to devitalize the root system inside the stone and prevents the aggressive suckering regeneration, considering the characteristics of lentisk shrubs.

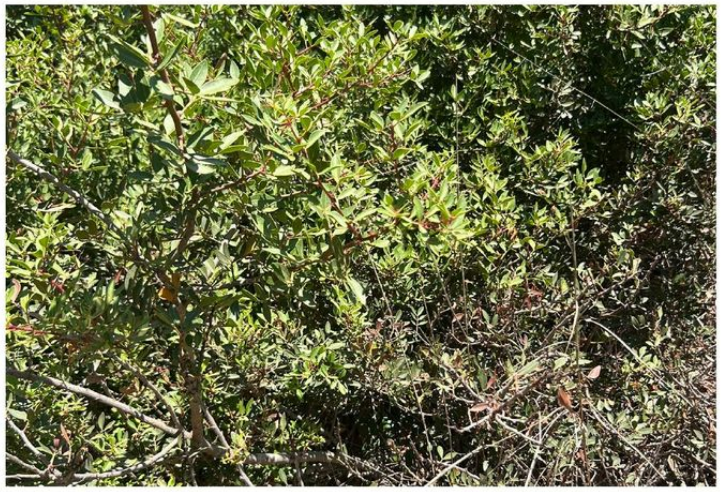


Figure 179. Lentisc / mastic (Pistacia lentiscus).

Structural Consolidation (Repointing)

After devitalization, the slowly decaying remained roots, could cause cavities that facilitate water infiltration and structural failures. Such cavities in the stone (if it is existing), should be structurally consolidated and repointed using natural hydraulic lime based mortars. This step provides the material and mechanical integrity and prevents structural collapse.
On the other hand, the roots remained in the soil, and could also leave cavities in the soil base that could also cause minor dislocations of the surrounding stones. These cavities must be infilled with compacted, homogenous, sterile soil or clean geo-aggregates compatible with the archaeological layers.
Containment Pruning (for Consolidating Roots)
For the lentisks to function as "consolidating vegetation", which refers to their roots as part of the material and mechanical integrity of the stone, there should be another intervention approach. However, pruning can be performed to reduce wind load on them, which creates tension on the stone structure. Reducing the crown volume by Selective Containment Pruning. It eliminates the sail effect and the lentisk can maintain its consolidating function within the stones.

Monitoring and Maintenance

The continuous monitoring should follow after the elimination and consolidation phases. If the new lentisk sprouts emerge from seed from the intervened areas, they must be extracted manually while they are young to avoid developing a thick, intrusive woody root system. Additionally, the decay process of the roots must be monitored to observe if new cavities occur. Whether the regrowth of the roots persists from the treated stumps, the localised herbicide must be implemented to the targeted vegetation.

6.6.3 Greek Strawberry Tree

Analysis

This plant has high aesthetic value in the area comparing the other plants (Fig. 180). Even though it does contribute visual or landscape benefits, the structural risk is created by its robust taproot at IP 6 index. Therefore, a direct elimination decision is applied to reduce the structural stability risk. Since the Greek strawberry tree didn't grow in direct contact with the remains, the intervention proposal should be improved by the plant's specific case.

- Hazard Index (IP): 6 (Moderate Danger)
- Root System: Robust Taproot / Very Intrusive
- Invasiveness: Not a Suckering Shrub
- Aesthetic Value: 1/3 (Low)
- Abundance: Very rare (Only 1 specimen in the area)

Interventions

Elimination

The shrub must be eliminated by the "cut-and-treat" process. After the shrub is cut on the base level, a triclopy based herbicide must be applied to the stump for devitalization.

Monitoring and Soil Consolidation

Observations should continue after the elimination for future sprouts and regrowth. The roots must be observed through the decay and decomposition to prevent structural failures due to the cavities. Crucially, as the cavities occur, they can not just be observed, but must also be actively filled with a compacted sterile soil or geo-aggregates.



Figure 180. Greek strawberry tree (Arbutus andrachne). Photograph by the author

6.6.4 Spanish Broom

Analysis

Spanish Broom adds a high aesthetic value and visual character to the area with its yellow flowers that bloom throughout the summer. According to modern conservation approaches, the complete (Fig. 181) elimination of "moderately dangerous" plants with high aesthetic value is neither necessary nor suitable. If there is no urgent situation that directly causes the structural risk, this plant is considered a part of the landscape that enriches the area and is managed through a 'prune-and-monitor' strategy, utilizing methods such as selective containment pruning."

- Hazard Index (IP): 6 (Moderate Danger)
- Root System: Robust Taproot / Very Intrusive
- Invasiveness: Not a Suckering Shrub
- Aesthetic Value: 3/3 (High)
- Abundance: Rare (Few in the area)



Figure 181. Spanish broom (Spartium junceum). Photograph by the author

Interventions

Selective Containment Pruning (Primary Strategy)

The primary intervention for spanish broom is the selective containment pruning. Its volumetric growth and canopy must be controlled by the periodic pruning activities in order to decrease the "sail effect" of the shrub. However, it minimizes the mechanical stress of its root system applies to the surrounding archaeological remains and soilbase. Thereby, this approach allows the plant to safely coexist with the ruins while maintaining its aesthetic value.

Contingency Elimination (Cut-and-Treat)

The strict contingency for this species addresses that if the "spanish broom" is found to be directly interacting with remains, it must be eliminated. Manual uprooting must be strictly avoided. Rather, a local "cut and treat" method should be applied. Therefore, the shrub must be cut at the base, and immediately, a compatible application of a triclopyr-based herbicide must be applied to the surface of the cut stump to prevent resprouting. This application helps to devitalize the root system inside the stone and prevents the resprouting.

Structural Consolidation (Repointing)

After elimination phase is applied, the slow decay of devitalized roots inside of the stone will leave cavities which is a threat for the structural stability. These cavities should be fulfilled with the "natural hydraulic lime based mortars". In order to maintain the ruin aesthetic, this mortar must be applied by the undercut (sottosquadro) technique.

Monitoring and Maintenance

Continuous monitoring should be implemented for assessing the success of "containment pruning"; in order to ensure if the roots are not shifting towards the visible remains.

Whether pruning is performed, the slow decaying should be carefully observed in order to avoid the cavity induced failures, and any potential sprouts in the treated areas must be manually removed at an early stage.

6.6.5 Thorny Burnet

Analysis

Thorny burnet (Fig. 182), although it is a very abundant shrub in the whole archaeological city, is found in limited numbers (at low density) in the cavea area. It has a moderate hazard index (IP: 5) and develops a problematic taproot that poses a structural threat to archaeological remains. Since it has no significant aesthetic or environmental value that would justify its preservation, its presence is considered harmful to the stability of the site area, and it should be removed.

- Hazard Index (IP): 5 (Moderate Danger)
- Root System: Woody Network / Intrusive
- Invasiveness: Subshrub
- Aesthetic Value: 1/3 (Low)
- Abundance: Highly abundant

Intervention

Targeted Elimination

According to the methodology, the species with moderate hazard index (IP= 4-6) have to be evaluated on a case-by-case basis. Since this species is abundant and does not possess any aesthetic or environmental value to justify its preservation, the selected intervention is the elimination. In order to prevent unnecessary use of chemical biocides, manual uprooting is suggested for the plant where the root is distant from the fragile ruins.

For Thorny Burnet knolls near archaeological remains, manual uprooting must be avoided because it will disturb the archaeological soil and destabilise the remains. Instead, a targeted micro-topical application (brushing the freshly cut basal stems) using appropriate biocides should be applied to devitalize the roots without subjecting the stones to mechanical shock.

Structural Consolidation and Cavity Filling (Repointing):

The underground cavities left by decaying toproots must be filled with the sterile geo-aggregates or natural hydraulic lime (if the cavities occurred in the soil base). The primary goal of this, restoring the mechanical capacity of the soil and preventing the surface water infiltration.

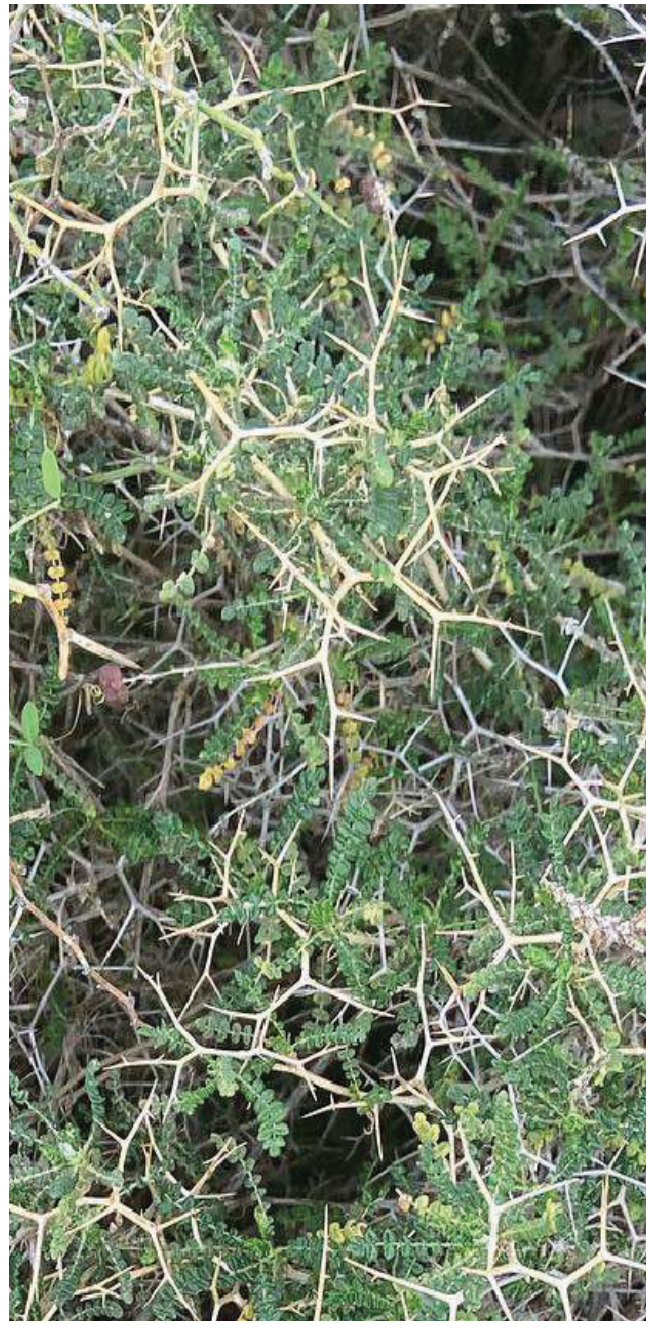


Figure 182.Thorny Burnet (Sarcopoterium spinosum)
Photograph by the author.

6.6.6 Rosemary and Oregano

Analysis

These abundant subshrub types (Fig. 183) pose a low structural risk as they grow a slight, non-intrusive taproot. While these subshrubs do not provide a significant aesthetic value to the site, according to Signorini's methodology, their low hazard index (IP ≤ 3) indicates that they do not pose an immediate structural threat to the archaeological ruins.

- Hazard Index (IP): 3 (Low Danger)
- Root System: Slight Taproot / Intrusive
- Invasiveness: Subshrub
- Aesthetic Value: 1/3 (Low)
- Abundance: Highly abundant

Intervention (Controlled Maintenance)

According to Signorini's methodology, low-risk species (IP 0-3) can be tolerated and generally ignored (trascurate) during weed control operations,. Therefore, the chosen intervention strategy for rosemary and oregano is "controlled maintenance." Periodic cutting of the small specimens around the ruins is sufficient to prevent excessive volumetric and radical growth. Aggressive chemical treatments or manual uprooting must be strictly avoided, as pulling the roots would cause much more mechanical damage to the fragile ruins than the plant itself.

Preventive Consolidation and Monitoring

Since the manual uprooting is not applied and the large root cavities are not expected; the abundance of Rosemary and oregano in the site requires a preventive conservation approach rather than eradication attempts. The surrounding existing cracks on the stones prone to colonisation, can be locally filled with "water repellent and anti-vegetative hydraulic lime mortars" to prevent the roots from penetrating in the first place.



Figure 183. Rosemary (Salvia rosmarinus).
Photograph by the author.

6.6.7 Thyme

Analysis

The structural risk of Thyme (Fig. 184) is negligible, as the plant grows a superficial root system which is called fibrous root system rather than a deeply penetrating taproot; thereby its overall root size can not grow significantly. According to Signorini's methodology, its low hazard index (IP :0-3), which addresses that it does not pose a mechanical threat to the archaeological ruins. The primary concern is potential long term moisture retention rather than being structural. Especially if thyme remains unchecked in shaded areas, it might create a humid microclimate that promotes moss growth.

- Hazard Index (IP): 3 (Low Danger)
- Root System: Without Taproot (Fibrous) / Not Intrusive
- Invasiveness: Subshrub
- Aesthetic Value: 1/3 (Low)
- Abundance: Highly abundant

Intervention (Controlled Maintenance)

The vegetation species has hazard index (IP) 0-3, can be tolerated; due to this reason the general strategy is focusing on microclimate-based maintenance.

- South Cavea (Shaded Zone):

The south cavea, as it is not exposed to sunlight annually and remains in the shade, the main risk is that the Thyme vegetation holds moisture on the surface, providing a basis for secondary biological colonisation, such as moss or cyanobacteria. Therefore, instead of uprooting the thymes, aerial cutting is recommended. As a result, the leaves and branches that retain moisture are removed. Beside, in the north part, monitoring can be done to the north part of the cavea, as the direct sunlight is stronger, the humidity is lower for any biological colonization to survive. No immediate intervention is needed in the north part of cavea.

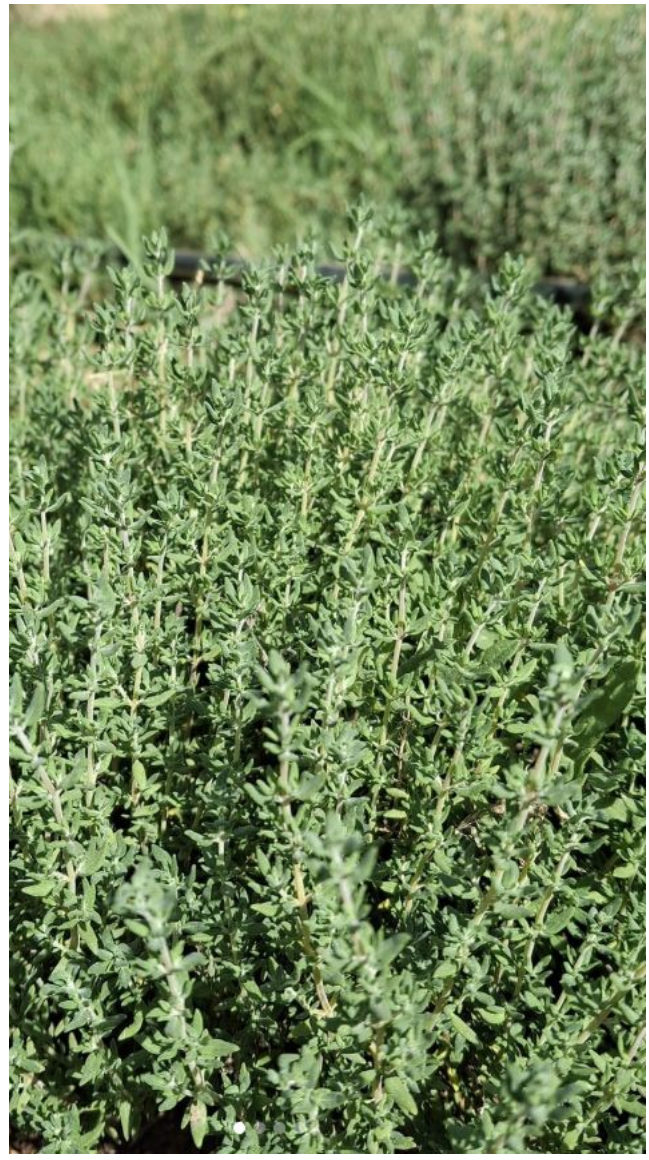


Figure 184.Thyme (Thymus capitatus). Photograph by the author.

6.7 Intervention Strategies for Trees

6.7.1 Methodological Approach to Tree Assessment

In the decision-making process for intervening with vegetation in archaeological areas, a comprehensive study should be conducted, going beyond subjective assumptions. While the flora can sometimes act as a protective layer for the remains, it can also damage them due to uncontrolled growth. Therefore, the decisions to manage risk-posing vegetation must be carefully balanced without eliminating the trace of time (*patina*) on archaeological remains. The analysis of these complex situations requires detailed, multi-criteria approaches. Following this approach, the analysis process has been conducted through step by step phases, culminating in the development of a targeted vegetation intervention plan. This progressive methodology ensures that any intervention is scientifically justified and adheres to the modern restoration principles of Minimum Intervention and Preventive Conservation.[116]

The "Indice di Pericolosità", known as IP, can be considered as a starting point. However, determining intervention strategies based solely on IP classifications is insufficient; as suggested by modern multifactorial models (such as the RHV index), biomechanical variables, material properties of the wood, topographic constraints, and the structural vulnerability of the remains should also be taken into account. In order to better understand the complex relationship between the root system and the plant structure, a series of investigations were conducted based on the "Tree Stability Assessment Protocol". According to modern arboriculture, evaluating a tree's safety requires combining visual diagnostics with precise mechanical calculations. This assessment follows two complementary methodologies:

- V. T. A. (Visual Tree Assessment) Methodology by Mattheck and Breloer, 1998
- S. I. A. (Statics Integrated Assessment) and S. I. M. (Statics Integrated Method) by Wessolly and Erb.

V. T. A. (Visual Tree Assessment) Methodology

The visual assessment of trees based on biomechanical methods was developed in Germany around the 1990s, with Claus Mattheck and Helge Breloer as its proponents.[117] This method aims to detect the internal defects and mechanical stresses of trees by examining their "body language". This method consists of three phases:
Visual analysis of the tree to detect external symptoms of any internal defects. Based on the observed symptoms, an experienced arborist can decide whether to proceed with a thorough investigation.
If significant symptoms are found, further analyses must be performed using appropriate instruments to confirm and quantify the related defects. Instrumental investigations in the second phase are performed only if there are symptoms that suggest internal alterations of a certain extent. These must therefore be verified and quantified using sonic tomographs and resistographs.
Based on the defects detected, the arborist determines the degree of danger of the tree and prescribes the necessary interventions. Remarkably, while V.T.A. is highly effective for visual diagnosis, modern tree statics demonstrate that assessing symptoms alone is not enough to accurately calculate the wind load or the structural stability of the tree. Therefore, visual symptoms must be evaluated by integration with the S.I.A. method.

S. I. A. (Statics Integrated Assessment) Methodology

This method, developed by Lothar Wessolly, is based on Limit-Load analyses.[118] When evaluating a tree as an engineering structure, it explains the wind load transmitted to the tree's trunk, roots, and soil by the wind coming to the tree's crown.[119] Most importantly, the tension and torsional forces created by the wind load are transmitted to the roots and, indirectly, to the soil and cavea blocks where the roots are anchored.

116. Brandi, Teoria del Restauro, 13–15, 47–50.;ICOMOS, Venice Charter (1964), Articles 4, 9.
117. Claus Mattheck, "Trees: The Mechanical Design" (Berlin: Springer-Verlag, 1991). See also Claus Mattheck and Helge Breloer, "The Body Language of Trees: A Handbook for Failure Analysis" (London: HMSO, 1994)
118. Mattheck and Breloer, The Body Language of Trees. For mechanical tree statics: Lothar Wessolly and Martin Erb, Manual of Tree Statics and Tree Inspection (Berlin: Patzer Verlag, 2016).
119. Wessolly and Erb, Manual of Tree Statics and Tree Inspection, 45–87.; Mattheck, Trees: The Mechanical Design, 89–112.

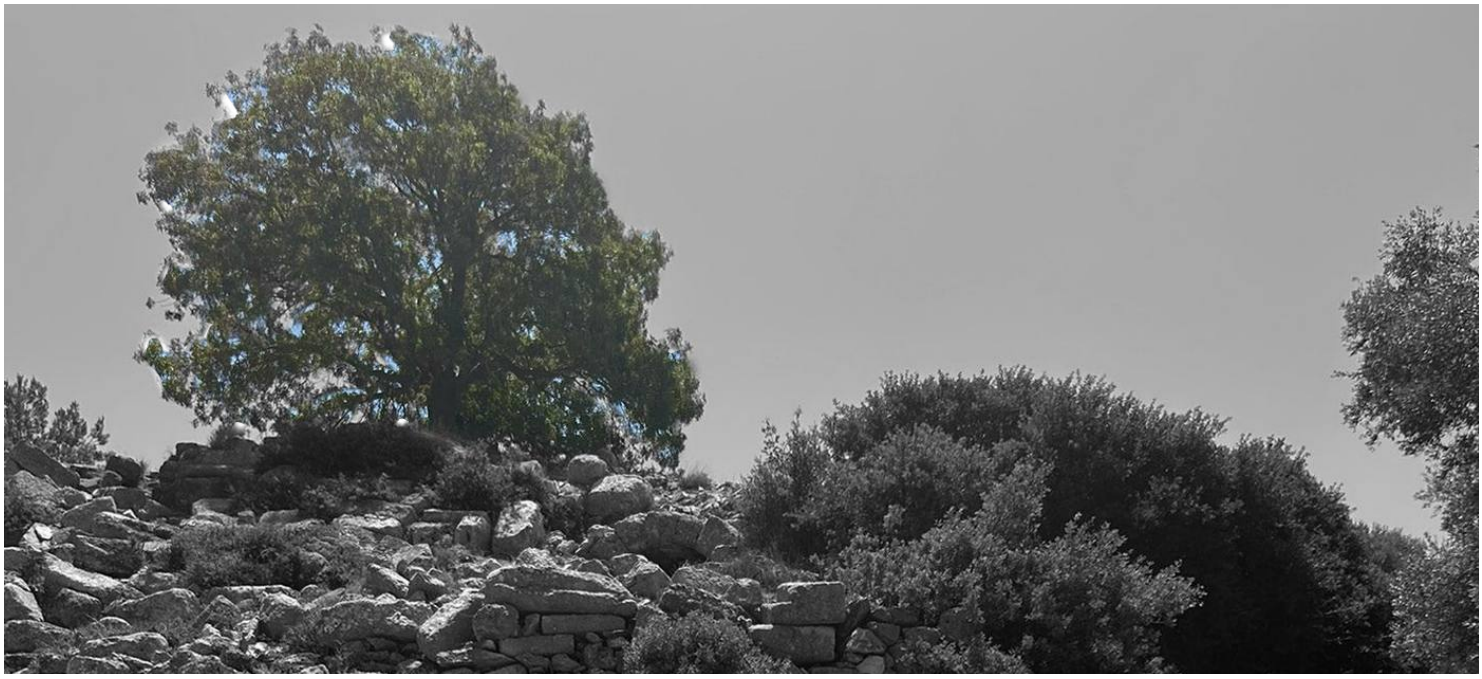


Figure 185. Kermes oak on the ancient theater, photograph by the author.

6.7.2 Specific Interventions for Kermes Oak

Diagnostic and Biomechanical Assessment (VTA & SIA)

Based on the preliminary analysis, the Kermes Oak (Fig. 185) was prioritized for initial assessment and intervention strategy. This tree's IP score (Hazard Index) and biological features, such as its ability to spread quickly in the area due to its radical suckers, its highly intrusive nature because of its robust taproot, its location in the cavea which puts it in direct contact with archaeological remains, its high abundance in the theater cavea, and its status as a veteran tree which could pose potential risks to the theater's structure, have been prioritized for analysis and evaluation. Because of its high hazard (IP>7) classification and proximity to the vault, preventive intervention must be executed proactively before the tree undergoes catastrophic biomechanical failure.

In this case study, the developed V.T.A. (Visual Tree Assessment) principles were applied to evaluate the "body language" of the tree, specifically focusing on the outer bark of the Kermes Oak, its root collar, and its asymmetric structure.

The tree's adaptation to the steep slope causes a shift in the center of gravity of the canopy, resulting in a leaning trunk structure. Therefore, the tree's structural vulnerabilities were evaluated in order to determine the most appropriate intervention strategies. Such strategies were fundamental to preventing the tree from applying additional thrust to the cavea, its seating blocks, and the adjacent vault. However, the wind load (F_{wind}) acting on to the tree's crown creates the bending moment on the trunk. The tree's load-bearing capacity was compared against these dynamic wind speeds. By following S.I.A. (Static Integrated Assessment) principles, it was evaluated whether the overturning moment transmitted to the root system and the underlying cavea stones exceeds the critical safety limit.

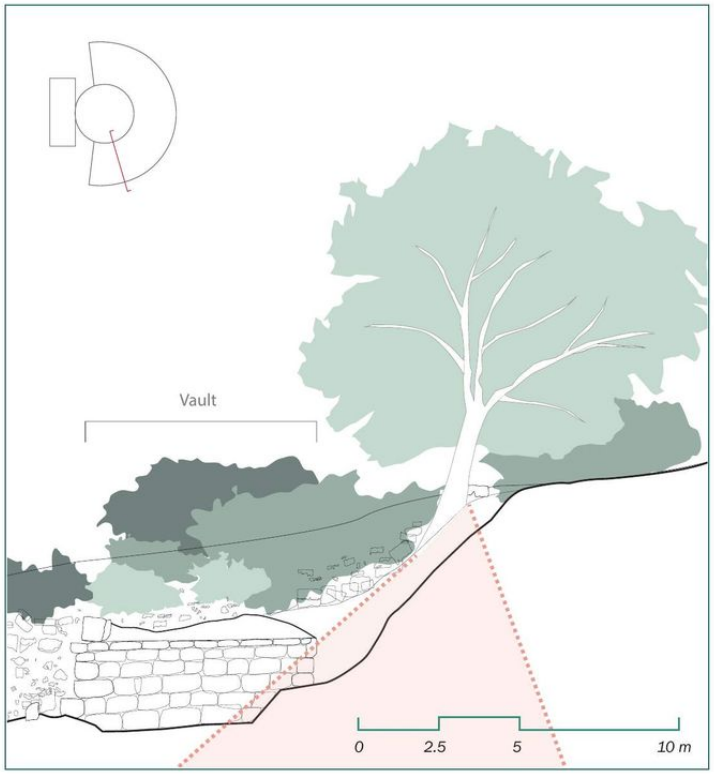


Figure 186. Section showing root systems in relation to the structure, with key plan. Drawing by the author.



Figure 187. Vault structure in the cavea. Photograph by the author.

Structural and Topographical Risk Assessment (Analysis of Dynamic Threats)

The tree is located on a steep slope within the theater's cavea (Fig. 186). The tree is visibly leaning, as shown in the cross-section drawing. When trees on such inclined terrain sway in the wind, their crowns undergo high oscillations that constantly stretch and loosen the soil structure beneath the root collar. This process causes the tree to slowly dig its own foundation (undermine itself), and the risk of falling increases gradually. According to S.I.A. principles, the tree trunk acts as a large lever. When the wind hits the crown, the roots extending beneath the stone blocks of the cavea are pulled upward like a catapult by the vertical tension force. In the event of severe winds, the tree's uprooting would lift the entire root plate, resulting in catastrophic displacement and destruction of the seating stones.

Potential Stresses on the Adjacent Vault and its Structural Vulnerability

The vault (Fig. 187) is located near the roots of the tree, and hypothetical analyses have been made based on the relationship between the crown width and the underground root spread. It was observed during the site visit that the roots have not yet penetrated this structure; however, the anticipated growth of the root system poses a significant threat to the adjacent vault, especially given the vault's unmaintained condition and existing structural vulnerabilities. When evaluating the impacts of the tree on the vault, the wind load acting on the crown is transmitted to the ground through the root system as "lateral and vertical thrust forces". Considering the veteran tree's age, the root system's ability to resist these dynamic loads is highly questionable. In the event of a possible biomechanical failure, such as a sudden tree fall or trunk collapse, the impact could cause severe damage to the adjacent vault and the surrounding archaeological remains. Moreover, the uprooting caused by the failure would leave deep subterranean voids that could compromise the overall stability in the cavea.

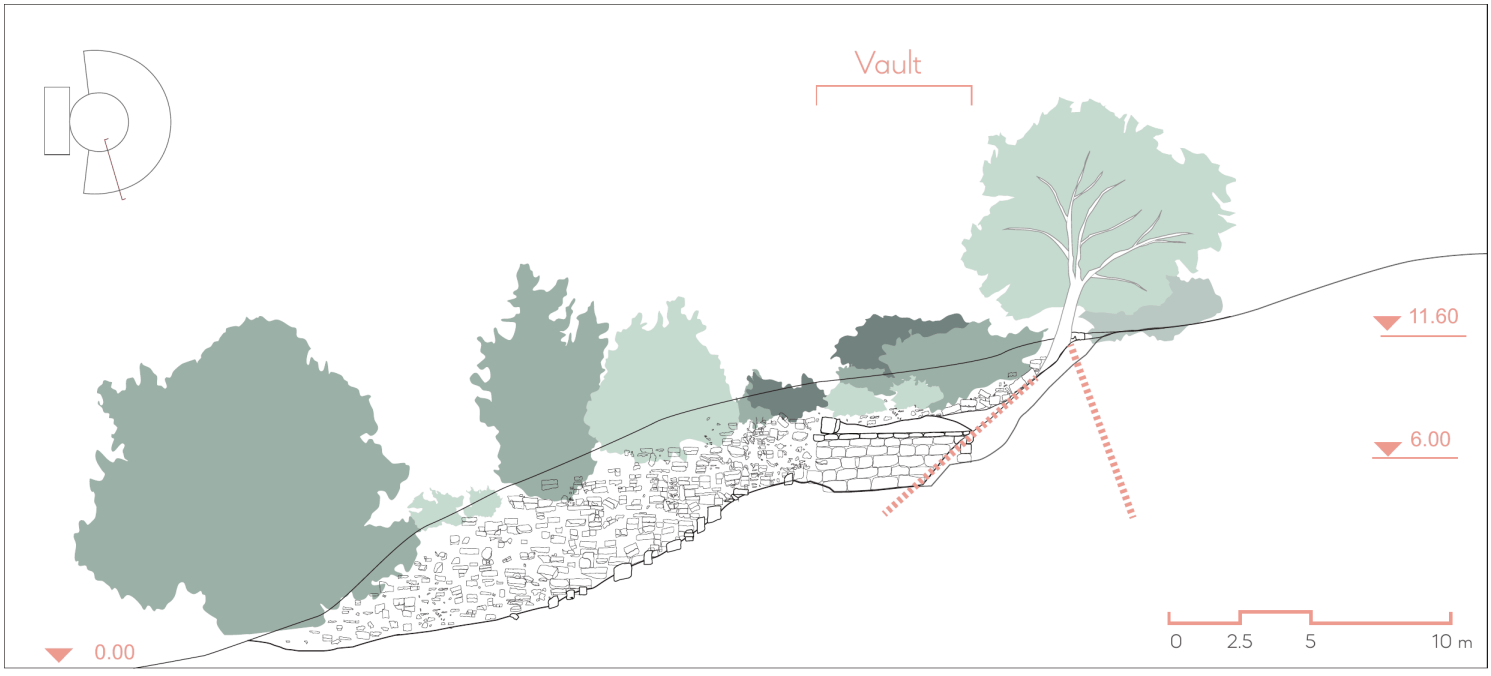


Figure 188. Section showing root projection, with key plan. Drawing by the author.

Non-Destructive Estimation of Root Interaction and Age

In order to assess the risks that the tree can pose, it is necessary to understand its age and the spread of its roots. It's important to understand whether the Kermes Oak extends far enough to compromise the vault, a critical element that helps distribute structural loads within the cavea. During this analysis process, it is required to estimate the spatial extent and aging stage of the unseen underground root system (root plate) using non-destructive methods. Based on Wessolly and Erb's approaches for solitary trees, the root zone area is generally considered equal to the tree's crown boundary line; and this line is calculated by adding an extra 1.5 meters measured from the trunk diameter.[120] This principle demonstrates that crown size directly indicates the minimum horizontal distance that underground roots will reach (Fig.188).

According to Mattheck's windthrow diagram, there is a direct correlation between the trunk radius (R) measured above the root collar and the root-plate radius (Rw). Utilizing this diagram, the boundaries of root expansion can be estimated simply by measuring the tree's trunk radius. Through this analysis, it is possible to estimate the area the Kermes Oak has invaded under the stone blocks in the cavea, as illustrated schematically in the cross-section. This assessment provides essential guidance for estimating the root zone, which is anticipated to impact the nearby vault and the cavea structure in the forthcoming years.

The root system of the Kermes Oak has penetrated between and under the seating blocks of the cavea, but no cracks or fractures caused by the tree's root system have been observed in the surrounding stone blocks. The roots, in their current state, have become a consolidation structure within the cavea's construction and are working as an integrated part of the architectural structure. Due to that reason, it shouldn't be considered a "damage repair situation"; instead, it necessitates a preventive conservation approach. Since the roots have become a system of the cavea, and recognizing the veteran tree's aesthetic contribution to the *Genius Loci* of the archaeological landscape, operations like root removal (eradication), which would create a shock effect on the cavea's structure and static condition, must absolutely be avoided during the interventions made to the tree. Consequently, the roots must be preserved *in situ*, as described by modern archaeological conservation principles.

Based on Mattheck's H/D (Slenderness) Ratio study (Fig. 189), the ages of trees can be estimated. Older (veteran) trees, like humans and animals, tend to become more compact. As a result, the Height/Diameter ratio decreases as the tree ages.[121] In veteran trees, the crown growth process stops, and the tree reaches its maximum size. Since the tree's crown reaches its maximum size and increases the biomechanical load on the supporting trunk, the tree enters a second thickening phase.

120. Wessolly and Erb, Manual of Tree Statics and Tree Inspection, 102–108.
121. Mattheck, Trees: The Mechanical Design, 55–62.

Following the research presented by Mattheck, the age of the Kermes Oak can be estimated. The tree was noted to be present on the site during the 1985 excavation works carried out by Erol Atalay, and it was also documented with photos. Based on the age analysis and the documented records we have, it can be estimated that the tree is at least 41 years old (Fig. 190, 191). Although this veteran tree does not need urgent intervention at the moment, its potential risks in the near future must be evaluated, and preventive intervention should be planned.

Intervention Strategy and Operational Procedures

This phase explains how diagnostic findings will be converted into an operational intervention process. The goal is to ensure structural integrity through the principle of minimum intervention while preserving the authenticity of the archaeological fabric. Accordingly, analyses are carried out to establish diagnoses, which have been created with mechanical diagnoses (VTA and SIA). Fully understanding the load transmission from the top of the tree to the seating stones allows for the next intervention to be carried out without being arbitrary, and to eliminate the identified mechanical threats without disrupting the archaeological stratigraphy, by precisely calibrating them.

Operational Standards for Stump Preparation

Following specialized archaeobotanical methodologies and modern arboricultural standards (such as ANSI A300 guidelines), the final trunk cut must strictly follow defined operational protocols to ensure the effectiveness of subsequent devitalization and consolidation phases:

- Horizontal Cut: Unlike standard arboricultural pruning, where angled cuts are preferred, the final cut of the stump must be perfectly flat and horizontal. This provides a stable, gravity-neutral platform for the drill-and-fill herbicide application and thereby ensuring that the subsequent liquid alkaline shield (limewash) can adhere as a thick, uniform layer without running off.
- Minimum Safe Height: The stump must be cut at the lowest possible height, strictly ensuring that the chainsaw does not come into physical contact with the archaeological stone surfaces.
- Clean Cambium Exposure: The cut surface must be clean but left naturally rough (un-sanded). This clearly exposes the active vascular cambium, the phloem/xylem ring between the bark and heartwood, which serves as the precise target zone for systemic herbicides.
- Immediate Intervention Window: To prevent the tree from naturally compartmentalising the wound and sealing its vascular tissues with sap, the devitalizing agents (Eco-Plugs) must be applied immediately, ideally within 15 to 30 minutes, after the final cut is executed.

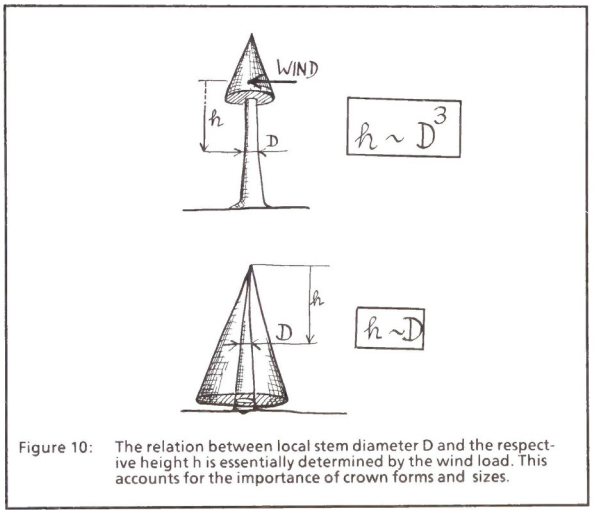


Figure 189. Tree biomechanics. Source: Mattheck (1991).



Figure 190. View of the theater at Notion from the 1985 excavation report. Source: Atalay (1986).



Figure 191. The same theater view angle of the excavation report picture. Photograph by the author.

Preventive Conservation

It addresses proactively managing conditions to prevent future damage. Therefore, the roots will be left *in situ* to maintain the static balance of the topography of cavea. Because the Kermes Oak aggressively produces water sprouts or sucker growth from the root collar out of a survival instinct when it loses its crown, local devitalizing agents will be applied to the vascular cambium. This blocks the phloem, preventing resprouting. The roots will then be forced into a slow decay phase. Consequently, the following closed-loop interventions will be implemented:

1. Devitalization (In-Situ Inactivation-Closed-Loop Intervention)

Since uprooting and extracting the root would damage the archaeological fabric (stratigraphy), the root is killed in place (devitalized) and left to decay naturally over time.

- **Intervention (Eco-Plug / Drill-and-Fill Method):**

Immediately after the tree is cut, holes are drilled around the perimeter of the stump (close to the cambium layer). Closed capsules containing systemic herbicide (Eco-Plugs) are hammered into these holes, or a very small amount of liquid herbicide is injected, and the holes are completely sealed with wooden plugs. This closed system is preferred over the surface brush application method.

- **Archaeological Advantage:**

The systemic herbicide is not left on the outer surface, spilled onto the soil, or released into the air. The closed drill-and-fill system minimizes the risk of herbicide dispersion into surrounding archaeological soils and groundwater compared to open surface application methods. The closed-system application method is widely preferred in sensitive heritage and landscape contexts because it reduces environmental exposure and limits dispersal into surrounding soils.

2. Preventing Recolonization (Alkaline Surface Shield) Procedure:

Instead of laying synthetic covers or suffocating it with backfill, a brush-applied, archaeologically compatible natural liquid barrier is applied to the stump surface left to decay.

- **Intervention (Limewash):**

Instead of toxic paints containing heavy metals (copper, etc.), a thick layer of natural slaked limewash or a lime-clay emulsion is applied with a brush to the exposed surface of the stump.

- **Result and Archaeological Compatibility:**

The high pH level (approximately 12 and above) of this applied lime layer makes the germination of new seeds dropped onto the stump by wind or animals physicochemically impossible (the alkaline environment instantly burns the seed). Because it contains no heavy metals, it never contaminates the archaeological soil. Since it forms a shield only on the applied surface, it does not interrupt the underground root decay and lime injection process.

- **Field Management (Monitoring) :**

Limewash is exposed to natural elements and reacts with carbon dioxide in the air to carbonatize over time (the pH level drops, turning it into harmless calcium carbonate). This is a highly advantageous characteristic in terms of not harming the soil; however, as the pH drops, surface protection decreases. Therefore, periodically renewing this lime layer (e.g. annually) until the roots completely decay and the process concludes must be included in the monitoring plan.

3. Management of Root Voids Through Hydraulic Lime Consolidation

Structural consolidation aims to maintain physical and mechanical resistance in the intervened tree and its root soil base. After the intervention of cutting the trunk of the Kermes oak, the slow decay process of the tree roots can create voids that can fill with rainwater, and with the effect of some animals or organisms, can create a productive soil habitat suitable

for new plant growth. In this case, after the tree trunk is cut, interventions with mineral-based materials should be applied to prevent the loss of stability of the ground, erosion, or water flow during the slow decay process of the roots. This will be done using cement-free hydraulic lime injections and breathable hydraulic binders to stabilize the soil around the root. The preference of intervention materials will be made following the principle of material compatibility. Specifically, this process is executed as follows: [122]

- **Procedure:**

The root system, which is deeply embedded in the soil and archaeological layers, is left entirely in place without any excavation.

- **Intervention (Cannulation and Injection):**

After the main trunk is cut, guide holes are drilled in the direction of the decaying roots, and flexible injection tubes (cannulas) are inserted. As the roots slowly decay over months/years; a cement-free, low-pressure, breathable, non-cementitious liquid hydraulic lime grout is periodically injected through these cannulas.

- **Result:**

The liquid lime seeps into the underground tunnels and cavities left by the decaying organic roots and hardens. As the roots gradually decay, localized and low pressure hydraulic lime injections may be used to stabilize selected subsurface voids only where necessary, reducing the risk of soil settlement and water accumulation while preserving the archaeological stratigraphy. Thus, without damaging the topography, ground subsidence and water accumulation are prevented (consolidated) from the inside.

4. Planned Maintenance and Monitoring

Maintenance in archaeological sites should be monitored as a continuous process. The voids in the root spots that may be formed by slow decay will be controlled periodically and the cement-free hydraulic lime injections that were applied before will be renewed when necessary.

- **Continuous Structural Monitoring:**

The vaulted relieving arch structure, which is highly sensitive to lateral thrust forces, will be equipped with micro-seismic and visual deformation sensors. The data will be logged continuously, with expert reviews conducted on a quarterly basis. This scheduled system guarantees the immediate detection of any micro-movements or potential collapse. Furthermore, this forthcoming controlling process can avoid a potential structural failure on the cavea.

A systematic maintenance plan can be applied as follows:

- Biannual Visual Inspections: The areas where tree roots are left in-situ can be visually monitored every six months, preferably after winter and summer, to monitor the slow decay process of organic matter and control surface erosion.

- Annual Consolidation Inspection: The micro-voids formed by the decaying roots can be evaluated annually, and cement-free hydraulic lime injections can be renewed when necessary to ensure structural continuity. Failure to perform regular checks and renewals can cause decaying tree roots to hold water, leading to the formation of a fertile soil base for new plant growth.

122. M. Farneti, E. Melandri, N. Terenzi, and A. Ugolini, "Il Parco archeologico di Suasa (AN): dalla domus dei Coiedii all'anfiteatro. La vulnerabilità ai margini dello scavo," Restauro Archeologico, no. 1 (2020): 26–43.

6.7.3 Specific Interventions for Terebinth

Diagnostic and Biomechanical Assessment (VTA & SIA)

According to the established decision-making methodology, the intervention strategy for the Terebinth (Pistacia terebinthus) was initiated with a preliminary botanical and spatial evaluation. Based on Signorini's Hazard Index, this specific tree is classified within the High Hazard (IP: 7-10) category due to its robust woody root system and its expansive canopy. Furthermore, the spatial proximity analysis revealed a "critical level" of interaction, as the tree has grown directly within the dry-stone masonry of the ancient theater's cavea.

The species in this high-risk category located in direct contact with vulnerable archaeological remains necessitate complete elimination. However, applying a straightforward eradication without a case-by-case assessment could pose severe secondary risks to the monument.

For improving the intervention strategies, the primary objective is maintaining structural integrity by following minimum intervention, preserving its authenticity. During the decision-making process, the mechanical assessments as VTA and SIA were conducted in order to analyse mechanical issues of the tree structure. The tree located among the remaining cavea stones, causes specific mechanical threats due to its wide crown. Therefore, a detailed analysis was conducted in order to provide scientific guidance for the intervention proposals.

Besides the mechanical problems of the tree, it also represents a significant conservation challenge due to its age and its critical position in the cavea. Before intervention decisions, the comprehensive risk assessment was required to evaluate risks related to its own structural integrity.

Visual and Biomechanical indicators assessed via VTA, supported by SIA has identified a several risk on the tree:

- The Risk of Overturning (Windthrow): The tree exhibits a stem failure due to its age, biomechanical defects identified during VTA, and lack of maintenance of the site.
-
- The Leverage Effect: The wide canopy of the tree acts like a sail during severe winds, generating a substantial leverage effect that transfers the wind load directly to the root collar. This persistent mechanical force significantly displaces, lifts and disrupts the original configuration of the ancient cavea stones.

Over the decades, the root system of the tree has penetrated deeply into the cavea structure beneath the seating blocks (Fig. 192, 193). Accordingly, the roots currently act like a consolidating structure within the cavea, and this crucial factor was taken into account during the formulation of the intervention proposals. While considering the preservation of vegetation that contributes to the *Genius Loci*, the high structural hazard posed by the leverage effect of this specific Terebinth outweighs its aesthetic value, necessitating its complete removal to safeguard the monument.

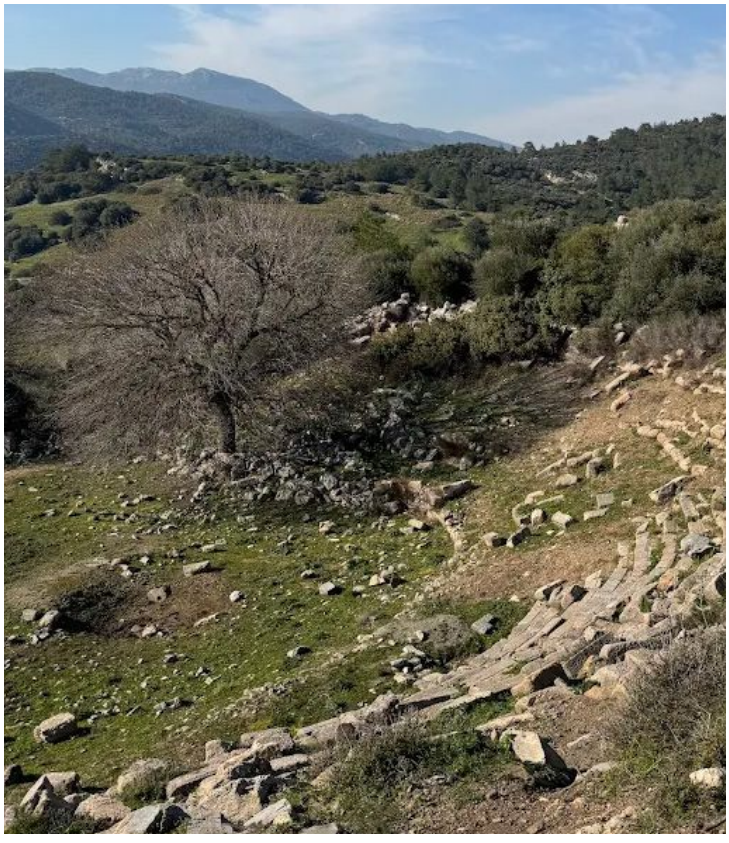


Figure 192. Terebinth tree in the cavea in early spring. Photograph by the author.

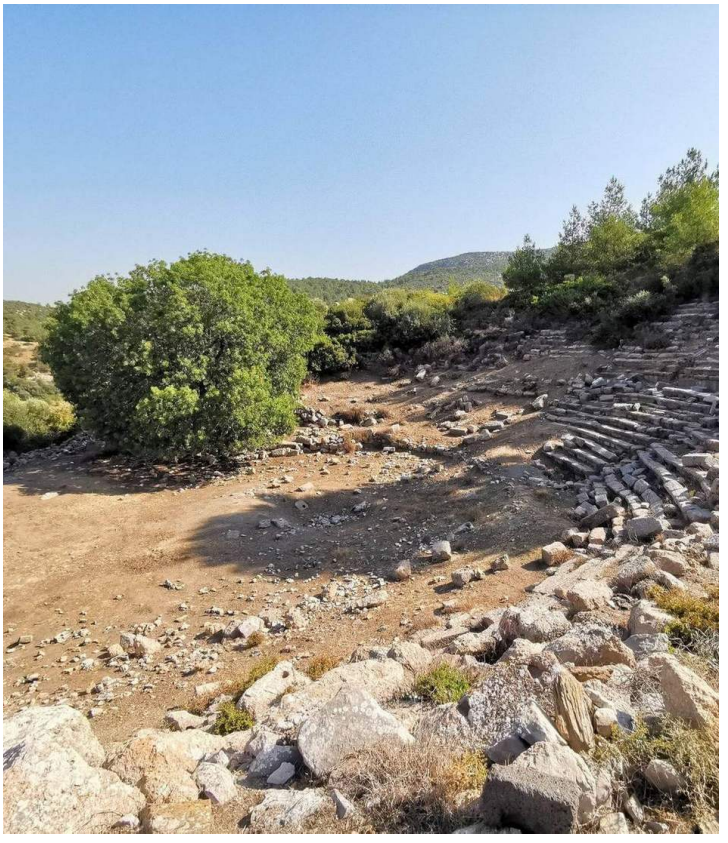


Figure 193. Terebinth tree in the cavea in summer Photograph by the author.

Intervention Strategy and Operational Procedures

Gradual Cut (Sectional Dismantling)

As previously stated, the sail effect of the crown and the trunk should be eliminated gradually using rope access techniques, including tree climbing and rigging, to prevent heavy wood pieces from impacting the remains. The gradual complete removal of the trunk will eliminate the bending moment and dynamic tension or lever stress on the seating stones, which helps to stabilize the cavea.

Stump Preparation:
The trunk cut and the subsequent devitalization process should follow specific operational protocols:

Horizontal Cut:
In order to ensure the efficacy of the localized herbicide application, the final stump cut be precisely flat and horizontal. This provides a stable surface for the drill-and-fill application and avoids the runoff of the subsequent liquid shields (limewash).

- **The minimum safe height:**
  The stump should be cut at the minimum feasible height, ensuring not contacting the archaeological remains.

- **Clean Cambium Exposure:**
  The cut surface must be naturally rough and unsanded. The cut operation remarkably exposes the active vascular cambium, specifically the phloem and xylem ring between bark and heartword, which is the area that the herbicide will be implemented on.

- **Immediate Intervention:**
  In order to prevent the tree from compartmentalizing the wound and sealing its vascular tissues with sap, devitalizing agents with drill-and-fill, must be applied immediately, preferably within 15 to 30 minutes following the final cut.

1. Devitalization (In-Situ Inactivation-Closed-Loop Intervention)

Since uprooting and extracting the root would damage the archaeological fabric (stratigraphy), the root is killed in place (devitalized) and left to decay naturally over time.

- **Intervention (Drill-and-Fill Method):**
  Immediately after the tree is cut, holes are drilled around the perimeter of the stump (close to the cambium layer). Closed capsules containing systemic herbicide (Eco-Plugs) are hammered into these holes, or a very small amount of liquid herbicide is injected, and the holes are completely sealed with wooden plugs. This closed system is preferred over the surface brush application method.

- **Advantage:**
  The systemic herbicide is not left on the outer surface, spilled onto the soil, or released into the air. Because the herbicide is trapped directly inside the stump, the risk of it being washed away by rain and leaching into the surrounding groundwater is considered relatively less. It is a method accepted for historical sites even by the strictest international environmental boards, providing the most definitive results without contaminating the soil.

2. Preventing Recolonization (Alkaline Surface Shield)

- **Localized Systemic Application :**
  The cut surface of the trunk should be ensured to avoid recolonization, thereby the high level pH a natural liquid barrier is applied with a brush rather than using synthetic covers or burying the stump in soil.

Intervention:
The exposed trunk is coated with a thick layer of natural limewash. This is used as a safe alternative to toxic paints that contain heavy metals like copper. The pH of the limewash is extremely high (pH + 12). This highly alkaline environment prevents the growth of any new seeds dropped by the wind or animals. Because it is free of heavy metals, it doesn't contaminate the archaeological site. Since it forms a shield only on the applied surface, it does not interrupt the underground root decay and lime injection process.

3. Management of Root Cavities

Once the main trunk is sectionally dismantled, the vascular connection is severed, completely halting the transmission of water and minerals to the roots and initiating their slow decay process. Therefore, it is necessary to determine how to intervene in the structural problems that the voids created by the rotting roots will cause in the soil. The voids created by the rotting roots can cause loads on the sloping land composed of cave soil and rocks, which can directly damage the structural integrity of the cavea and cause the seating stone remains in the cavea to dislocate.

- **Intervention (Cannulation and Injection):**
  After the main trunk is cut, guide holes are drilled in the direction of the decaying roots, and flexible injection tubes (cannulas) are inserted. As the roots slowly decay over months/years; a cement-free, low-pressure, breathable, non-cementitious liquid hydraulic lime grout is periodically injected through these cannulas.

- **Result:**
  The liquid lime seeps into the underground tunnels and cavities left by the decaying organic roots and hardens. As the roots gradually decay, localized and low pressure hydraulic lime injections may be used to stabilize selected subsurface voids only where necessary, reducing the risk of soil settlement and water accumulation while preserving the archaeological stratigraphy. Thus, without damaging the topography, ground subsidence and water accumulation are prevented (consolidated) from the inside.

4. Monitoring and Field Management :

The lime layer applied to the cut surface of the Trunk hardens when it comes into contact with air and turns into harmless calcium carbonate over time. This is ecologically compatible with the natural environment around the tree, but since the protective property of the lime decreases over time, we need to renew this lime layer every year so that the protection shield does not weaken, and new colonizations do not occur on the trunk.

6.7.4 Specific Interventions for Turkish Pine

Diagnostic and Biomechanical Assessment (VTA & SIA)

The Turkish Pine is situated on the upper part of the cavea (Fig.194), close by the surrounding slightly buried and exposed seating block remains. Its wide crown causes the leverage effect on cavea, which causes instabilities for the slope topography, surrounding remains. Besides the structural stability issues of the examining case, it is also crucial to consider potential risks that will occur while the tree is aging.
As in the previous intervention proposals for the trees, the preliminary analysis of the tree was conducted in order to understand its structural vulnerabilities and possible decay issues within its body or in its root structure. Therefore, V. T. A and S. I. A methods were utilized during the preliminary investigations.

1. Wind Load and the Effect on Roots:

The transmission of wind load on the tree's crown to the roots as tension and overturning moment is recognized as "leverage effect "defined by SIA (Static Integrated Assessment) method of Lothar Wessolly. He defines that the tree acts as a cantilever structural element, so the acting wind load on the crown is transmitted to the root as an "overturning moment". Beside, the SIA-method compares the size and shape of the tree crown to the thickness of the load transferring trunk. His structural explanation gives a guidance to examine the structural and mechanical behaviour of the young Turkish pine located on the cavea. For biomechanical investigations of the tree, as in the previous tree analysis, the V. T. A. (Visual Tree Assessment) method by Claus Mattheck was utilized in order to diagnose the decay and illnesses of the tree. Hence, this method suggests observing the biomechanical signals visible on the tree trunk, as internal decay is often reflected externally through textures, abnormal swellings, cracks, ribs, fungal fruiting bodies, and bark defects. Following these guidelines, no biomechanical decay has been detected in Turkish Pine.

2. Radial Thickening and "Root Wedging" (Dislocation Risk)

The roots of trees like pines grow, they undergo radial thickening and apply a high outward pressure to the area and structural parts it has located. This mechanical stress created by the roots, can cause the enlargement of the existing cracks, displacement of the stone blocks and ultimately the loss of structure's load bearing stability.

3. The Necessity of "Preventive Intervention" at an Early Stage (Management of Future Risks)

The fact that the age of the tree is still young is not a reason to consider potential risks might occur in the forthcoming decays; however, preventive interventions should be considered to eliminate these potential risks. Pine species such as *Pinus Brutia* on the cavea, due to their strong, massive and widely spreading root systems are evaluated in the highest risk category of IP=8 in Maria Adele Signorini' s Hazard Index assessment. According to the following approaches, such high index plants have to be managed or removed from the site in their early stages to prevent possible structural failures. Coniferous trees like pines do not produce new shoots (suckers) from their roots or remaining stumps once they are cut. This biological fact directly impacts the intervention strategy. Classification Based on Suckering Capacity According to Maria Adele Signorini's Hazard Index (IP) system found in the literature, trees (Biological Form 8) are classified into three main categories based on their ability to sprout and regenerate:

- 6.0 - *Non polloniferi* (Not suckering): Trees that do not sprout again when cut.
- 6.1 - *Con polloni di ceppaia* (With stump sprouts): Trees that shoot new branches directly from the cut stump.
- 6.2 - *Anche polloni radicali* (Also radical suckers): The most invasive species (like *Ailanthus altissima* or *Ficus carica*) that shoot new saplings both from the stump and from their underground root network.



Figure 194. Turkish Pine tree in the cavea in summer season. Photograph by the author.

The biological status of Turkish Pine belongs to the "Not suckering" category. Unlike broadleaf trees, when the pine tree's main trunk is cut below its green canopy, the tree completely lacks the biological survival reflex to generate new shoots from its stump or underground roots. Even though the pine trees do not sprout back when they're cut, the potential danger that must be considered is not recolonization or sprouting; rather, it is expansive root systems that might cause severe mechanical problems on the cavea's structure and stability of remains.

Preventive Intervention Strategy

Phase 1: Devitalization

Unlike the Kermes Oak, the devitalization of the pine tree is not needed. Since the pine tree and its root system starts to decay after its trunk is cut, there is no need to apply a localized herbicides to the cambium layer and use "drill-and-fill" method. Accordingly, the mechanical cutting itself provides an effective devitalization for the roots.

Phase 2: Avoiding the Recolonisation on the Decaying Roots

Due to the young age of the Turkish Pine, the voids created by its decaying roots are significantly less voluminous than those observed in the veteran Kermes Oak. However, the dead roots of Pine Tree pose no threat of regeneration, yet the concern is preventing new, wind-blown seeds from settling into the nutrient-rich humus formed by the decaying roots. In order to achieve this, simply applying the inorganic gravel mulch (brecciolino) over the topsoil will act as a physical barrier which is called a capillary break.

6.7.5 Specific Interventions for Wild Olive

Diagnostic and Biomechanical Assessment (VTA & SIA)

The ancient theater of Notion hosts a great diversity of plant species, integrating the archaeological heritage with the natural landscape. The intervention strategies have been developed on a case-by-case basis for the existing vegetation rather than transforming the site into a sterile museum environment. Such strategies are based on targeted analyses to determine whether specific vegetation poses a threat to the remains. Within this framework, the initial assessments have evaluated the IP scores of the vegetation, its proximity to the remains and its age, alongside detailed Visual Tree Assessments (VTA). Alongside this, the structural vulnerabilities of the theater's cavea were also examined. Including all these preliminary analyses, the intervention strategies for trees were established and prioritized for specific tree species. Based on these comprehensive assessments and recognizing its high aesthetic contribution to the *Genius Loci* of the archaeological landscape (Fig. 195), the veteran wild olive tree has been prioritized for immediate and conservative intervention.

The tree's crown was identified to have structural defects after recent inspections. In particular, V-shaped branches were identified as a major risk because they produce mechanically fragile places and raise the possibility of splitting. Additionally, crossing branches that rub against each other damage the protective bark, creating direct entry points for fungal pathogens that cause decay. The analysis demonstrates that the continuous, asymmetrical expansion of the specimen's crown across the sloped topography constitutes the primary conservation and stability concern, rather than issues related to the root structure.

Due to its broad, spreading form, the wild olive experiences structural challenges predominantly resulting from gravitational forces, in contrast to trees that are mainly compromised by wind-induced leverage. Overextended lateral branches extending downslope significantly increase the bending moment and static stress on the root plate, as these branches act as long lever arms.

Root System of the Wild Olive (*Olea europaea*)

Since the wild olive tree, genetically programmed to survive in harsh conditions, develops a deep taproot in its youth, this vertical root loses its function as the tree matures and is replaced by an extremely strong, expansive, and shallow lateral root. Roots perform a series of complex functions such as the absorption and transport of water and mineral substances, synthesis of organic compounds, carbohydrate storage, and anchoring the plant to the soil. As with the above-ground (epigeal) organs, the root system is much more complex in tree species compared to herbaceous species. However, the root system of a monumental Wild Olive (*Olea europaea*) tree shows extraordinary evolutionary and morphological flexibility in adapting to dry Mediterranean climates and rocky or archaeological terrains. The horizontal root system, typically concentrated within the upper 60–100 cm of soil, can extend over an area three to four times wider than the crown (canopy), thereby maximizing water collection efficiency. (Fig. 196) The age factor also directly affects the spread and depth of the root system; in a centuries-old olive tree, lateral root formation is shaped entirely by environmental conditions, topography, and physical obstacles such as archaeological remains. Since there are no predetermined structures (depending on xylem arches), the olive tree has the capacity to develop new adventitious roots and basal sprouts immediately when needed, damaged, or under mechanical stress.

For these reasons, it is not possible to speak of a "typical" or symmetrical root system for this monumental olive tree. The sloped terrain on which the tree is located, its massive trunk structure, and the downward-stretching asymmetrical crown have transformed root development into a biomechanical necessity.

While roots spread almost homogeneously in the soil under flat and normal conditions, the roots of the wild olive differentiate as follows in a tree with a high slope and an asymmetrical center of gravity, such as in this case area:



Figure 195. Wild olive tree in the cavea of the ancient theater. Photograph by the author.

Tension Roots:
On the part of the tree opposite the slope direction (uphill), extremely long, thick, and rope-like strong lateral roots have formed to resist the "tension" created by gravity and the weight of the canopy hanging downhill. These roots anchor the tree to the hillside.

Compression Roots:
In the part developing in the direction of the slope (towards the theater cavea / archaeological remains), the roots are shorter and thicker. These act as support columns that transfer the massive asymmetrical load to the soil and tend to develop in depth. It is observed that the olive tree's root system spreads over a much wider area in the opposite direction of the slope, while it narrows to meet the pressure in the downhill sections. In terms of tree mechanics, while trunks often fail via compression buckling under bending stress, the root plate is highly vulnerable to tension failure during overturning. Because the tensile strength of the wood tissue and root system is nearly twice the compressive strength, reducing the weight of the downward-stretching asymmetrical crown (crown reduction) is the most vital intervention to alleviate the destructive leverage on the tension roots and minimize the compressive load pressing onto the archaeological remains beneath them.

Crown Management and Mechanical Support Strategy
Pruning can be used to reduce mechanical tension and physical stress by minimizing branch density. Furthermore, high-humidity microclimates created by overgrown branches could accelerate the biological decay of surrounding archeological remains. Careful pruning and targeted interventions are essential to reduce both these mechanical and environmental risks.

Crown Management and Pruning Strategies
There are various pruning typologies in arboricultural practices. Following ISA best management practices (ANSI A300), adapted to the Mediterranean and Anatolian context, the most commonly used pruning methods are classified into two categories:

- **Dormant Pruning:**

Performed during the inactive period of the tree. This includes: structural/formative pruning, maintenance pruning, crown thinning, crown reduction, and restoration/rejuvenation pruning.

- **Growing Season Pruning:**

Takes place in the summer months when the tree is actively growing.

When deciding on the appropriate pruning method, it's crucial to consider the tree's age and contextual factors. Pruning methods like topping have been rejected by modern arboriculture and severe rejuvenation pruning should be strictly avoided. In vegetation species with a high capacity for vegetative propagation, such as the Wild Olive Tree, severely pruning the entire crown triggers an aggressive survival response, causing it to violently produce root suckers that could further damage the ancient masonry.



Figure 196. Olive tree's root projection and branching diagram on the theater. Drawing (on the left) and photograph (on the right) by the author.

On the other hand, standard maintenance and structural pruning, which merely preserve the existing crown, are not enough to reduce the effect of wind load and gravity on the tree. For Wild Olive trees, "Crown Reduction" and "Crown Thinning" are recommended methods. This combination approach is traditionally used to manage trees restricted by environmental challenges, making it the ideal solution for managing an old tree located on slope bordering to cavea.

Reasons to thin the canopy can be:

- Reduce risk of storm damage,
- Improve growth on turf and other plants shaded by the canopy,
- Improve appearance,
- Open up a view,
- Show off attractive bark or trunk form,
- Reduce pests by improving air flow,
- Compensate for included bark and other defects.

Proper thinning does not change the overall size of the tree, which will remain about the same height and width as it was before thinning. Proper thinning is done on relatively small branches in the leafy area of the canopy toward the ends of the main branches. Remove branches growing parallel to each other attempting to occupy the same space. Canopy reduction makes a tree smaller by removing the end portion of branches with reduction cuts.[123]

Biomechanical safety should be ensured by eliminating the structural risk by avoiding excessive pruning. The "Crown Reduction Risk" defines the safe zone for the crown of the tree, ensuring that lateral branches do not exert excessive static weight and act as leverage on the topography (Fig. 197, 198). The inclined structure of the tree's body on slope causes asymmetric loading on the root system. Therefore, the application of the mentioned pruning strategies is quite suitable for solving these described structural defects given the tree's behaviour on the slope. When the lateral branches of the Wild Olive (*Olea europaea*) exceed the "safe radius," the reduction pruning and thinning strategy is strictly to be implemented.

Crown thinning will especially aim to remove the crossing and rubbing branches. However, the open wounds can be prevented by eliminating these friction points : thereby protecting the body of the tree from the decay causing pathogens. The crown reduction should be operated to the heavier or more overextended dominant stems in order to solve narrow-angled V crotches potential problems. This helps to reduce arm effect on the weak branches, mechanically decreasing the pulling force and risk of splitting failure. Once the proper thinning pruning is performed on mature trees, secondary branches and small twigs along the main limbs should be preserved. Poor thinning techniques that result in weak, awkward structures where foliage is clustered only at the tips (often referred to as "lion-tailing") must be strictly avoided. Correct thinning reduces crown density without significantly shrinking the overall size of the tree, allowing wind and light to pass through the canopy and improving stability during storms. Additionally, pruning cuts should ideally be restricted to branches less than 2 inches (approximately 5 cm) in diameter.

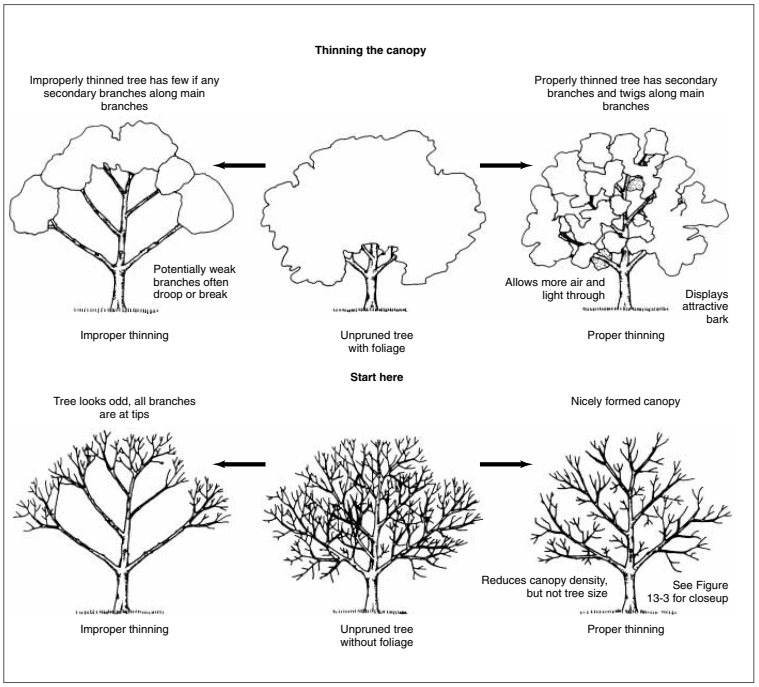


Figure 197. Processes and types of canopy thinning. Source: Gilman (2012).

During the cutting operation, the branch protection zone and the branch bark ridge at the branch attachment point must not be damaged. These tissues form a critical defensive barrier that facilitates the closure of the pruning wound and prevents decay organisms from spreading into the main trunk. While young trees can tolerate the removal of up to 40% of their photosynthetically active mass, every vegetative branch is incredibly valuable for the energy balance of a veteran tree like the Wild Olive. Consequently, the targeted weight reduction will not exceed 15-20% of the live crown volume. The most appropriate season for these pruning operations is late winter to early spring (Dormant Pruning). Interventions during the active spring flowering period or extreme summer drought must be avoided to prevent the tree from experiencing severe physiological stress and depleting its energy reserves.

123. Edward F. Gilman, "An Illustrated Guide to Pruning", 3rd ed. (Clifton Park, NY: Delmar Cengage Learning, 2012), 208.

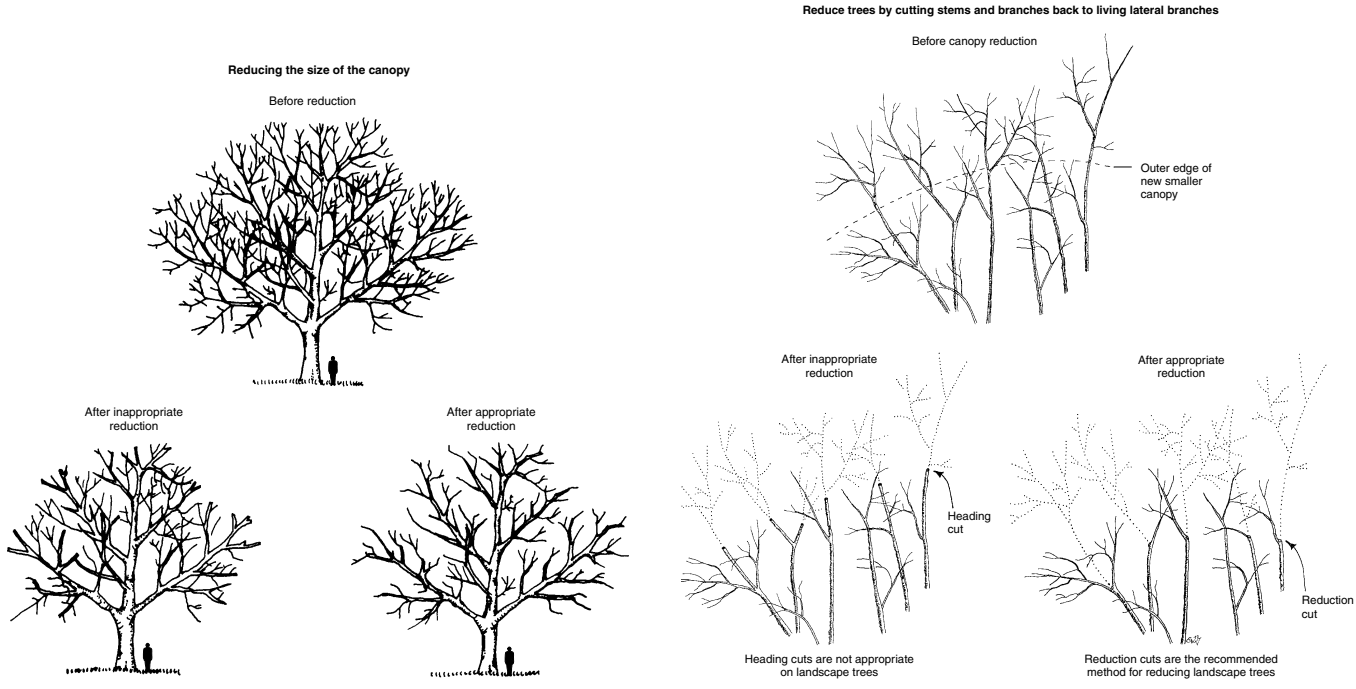


Figure 198. Pruning-technique diagrams (branch removal). Source: Gilman (2012).

Mechanical Support Strategy (Non-Invasive Dynamic Cabling)

Wild olive trees frequently develop narrow-angled 'V' shaped crotches as they grow. Due to this tight angle, bark often becomes trapped between the joining branches (a condition known as included bark), preventing the formation of strong connective wood tissue. This structural defect makes the heavy branches extremely vulnerable to splitting and tearing under their own weight or environmental stresses such as wind. Since the intervention is strictly necessary to prevent the tree from splitting in half, removing these branches is not a viable option.

The complete removal of overextended horizontal branches, which are physiologically vital for a veteran tree, can cause serious energy imbalances and possibly lead to large columns of decay progressing towards the trunk. Traditional mechanical support methods, such as rigid steel cables and through-bolts, are not preferred for intervening in the V-shaped branches of a wild olive tree. Drilling directly into the branch damages the tree's natural defence mechanisms, leaving it vulnerable to fungal pathogens and wood decay, and particularly violates the Compartmentalisation of Decay in Trees (CODIT) system.

Therefore, a Non-Invasive Dynamic Cabling system is required. This cabling system is extremely critical for physically securing the vulnerable narrow-angle "V" crotches that include the bark, and it functions as a safety net against splitting failures. This modern method uses UV-resistant synthetic ropes rather than hard steel (Fig. 199).The anchoring system could be implemented by wrapping synthetic slings around the sensitive branch and the main branch. This system allows the branch to bend naturally when a lateral force is applied, enabling the branch to flex.[124] This movement of flexibility does not hinder the plant's physiological and biomechanical strengthening and can be defined as a healthy precaution.

124. International Society of Arboriculture (ISA), "ANSI A300: Standards for Tree Care Operations" (Champaign, IL: ISA, 2017). For the specific application of non-invasive dynamic cabling in heritage tree contexts, see also Wessolly and Erb, Manual of Tree Statics and Tree Inspection, 145–150.

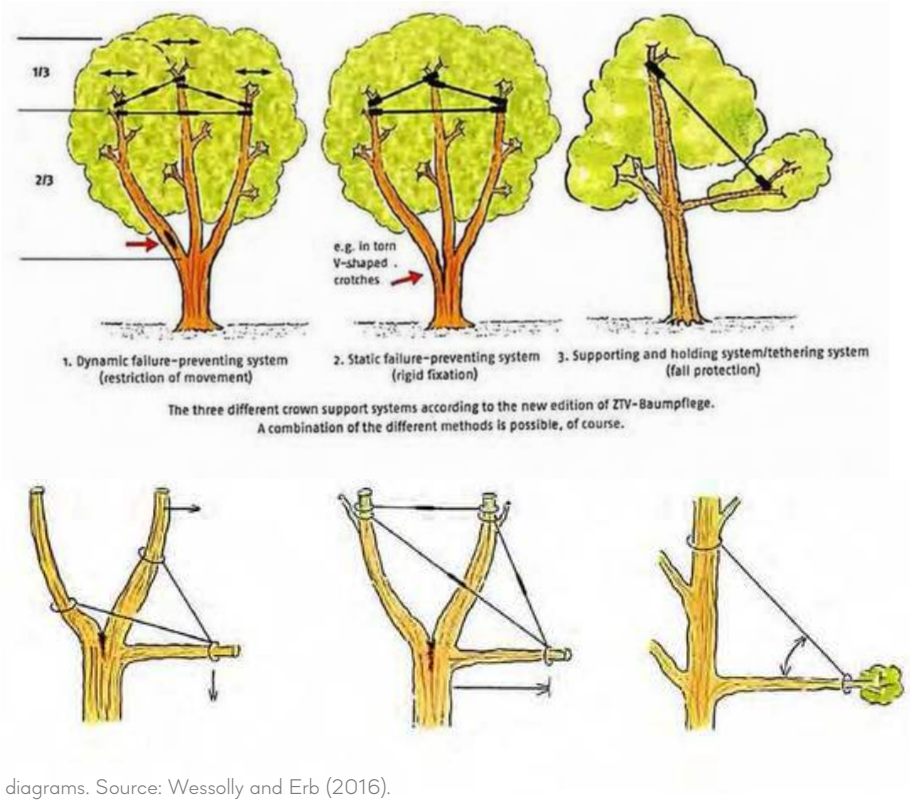


Figure 199. Tree-statics and cabling diagrams. Source: Wessolly and Erb (2016).

The examination of the tree should be performed correctly in order to ensure the compatibility of the methods to be recommended. The wild olive tree represents two major biomechanical problems; the unbalanced gravity caused by the sloping land and the included bark in the narrow V crotches. However, the risk of splitting is quite high between these co-dominant stems, due to their self-weight and wind load. Crown reduction alone does not fully mitigate this risk. Addressing weight imbalances in the large trunk of the tree is also required. Pruning veteran trees reduces photosynthetic capacity and disrupts the tree's energy balance. Therefore, weight reduction achieved through pruning should be supplemented with both physical and mechanical support.

The installation of the Dynamic Cabling

The installation should be operated with some engineering steps. According to the addressed structural defects of the tree, dynamic failure-preventing system" must be operated.

Positioning:

The support system should be installed at approximately 2/3 of the total branch height, beginning at the junction of the weak co-dominant stems. This height ratio minimizes the lever arm effect and provides optimal anchoring strength.

Broad Synthetic Slings and Expansion Inserts:

It is recommended to use flexible, UV resistant synthetic slings wrapped around the branches instead of drilling into the trunk. This ensures the vascular bundles are not damaged and the cambium layer remains protected.

Shock Absorbers:

A shock absorber must be added to the synthetic rope connecting the two branches. This addition makes the system dynamic and flexible, it allows micro movements. Therefore, using a system that allows these movements supports the biologically damaged parts of the branch to strengthen itself.

07.

SITE ENHANCEMENT AND DESIGN PROPOSAL

7.1 Legislative Framework for the Protection of Archaeological Heritage in Turkiye

Historical Evolution of Heritage Legislation

Turkiye's legislative framework for the protection of cultural heritage has its origins in the final decades of the Ottoman Empire. The first attempt to regulate the treatment of antiquities dates to 1869, when the Ottoman government proposed measures to control the export of objects found on Ottoman soil. This proposal was formalised in 1874 through the Asar-ı Atika Nizamnamesi (Regulation on Antiquities), a thirty-six-article statute that defined the nature of antiquities, established conditions for licensed excavation, and introduced a tripartite system for distributing finds between the excavating director, the landowner, and the state.[125]

The decisive reform came in 1884 under the direction of Osman Hamdi Bey, director of the Istanbul Archaeological Museum and a pioneering figure in Ottoman heritage protection who is widely credited with transforming the institution into a leading centre of archaeological scholarship.[126] The 1884 regulation declared unconditional state ownership over all antiquities, marking a fundamental shift from the earlier framework in which private landowners retained rights over objects recovered on their property. A further revision in 1906 reinforced this principle and tightened excavation procedures, remaining in force until superseded by Law No. 1710 in 1973.[127] However Law No. 1710, the Eski Eserler Kanunu (Ancient Monuments Act), was significant in introducing the concept of the protected "site" (sit alanı) into Turkish law for the first time, acknowledging that heritage protection must extend beyond individual objects to encompass entire landscapes and their spatial contexts.

Law No. 2863 and the Current Regulatory Framework

The principal legislation currently governing heritage protection in Türkiye is Law No. 2863, the Kültür ve Tabiat Varlıklarını Koruma Kanunu (Law on the Conservation of Cultural and Natural Property), enacted on 21 July 1983, published in the Official Gazette on 23 July 1983, and subsequently amended in 1987, 2004, 2009, and 2011.[128] Article 3 of the Law provides the foundational definitions. A "cultural asset" is defined as any movable or immovable property of historical, artistic, scientific, or social significance from before or after recorded history.[129] An "archaeological site" is defined as an area where the material products of successive civilisations converge within a topographically coherent zone that retains historical, archaeological, artistic, scientific, social, or technical value and that exhibits partial surviving structures.[130]

Under this framework, archaeological sites are classified according to a three-degree system by the Regional Cultural Heritage Conservation Boards (Kültür Varlıklarını Koruma Bölge Kurulları), of which there are thirty-three operating across Turkiye's eighty-one provinces. A First Degree Archaeological Site (Birinci Derece Arkeolojik Sit) designates areas of national or international significance in which virtually all physical intervention is prohibited. A Second Degree site permits limited scientific investigation under board supervision, while a Third Degree Archaeological Site (Üçüncü Derece Arkeolojik Sit) allows compatible land use and constrained development subject to prior approval from the relevant regional board.[131]

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125. The first Ottoman regulation on antiquities dates to 1869, followed by the formal Asar-ı Atika Nizamnamesi of 1874, consisting of 36 articles. The 1874 regulation divided finds equally between the state, the landowner, and the excavation director. See E. Yücel, Türkiye'de Müzecilik (Istanbul, 1982), 53.
126. Yücel, Türkiye'de Müzecilik, 53. Osman Hamdi Bey was appointed director of the Istanbul Archaeological Museum in 1881 and is widely credited with transforming and expanding the institution. See also Zeynep Eres, "The Changing Policies on the Protection and Management of Archaeological Sites in Turkey," Internet Archaeology 54 (2020).
The 1906 revision remained in force until superseded by Law No. 1710 (Eski Eserler Kanunu) on April 25, 1973. The 1973 law introduced the concept of "site" (sit alanı) into Turkish legislation for the first time.
127. Republic of Turkey, Law No. 2863 on the Conservation of Cultural and Natural Property, Official Gazette No. 18113, July 23, 1983. Amended by Law No. 3386 (1987), Law No. 5177 and No. 5226 (2004), Law No. 5835 and No. 5917 (2009), and Laws No. 648 and No. 653 (2011).
128. Law No. 2863, art. 3 (a).
129. Law No. 2863, art. 3 (m).
130. The three-degree classification system is established through decisions of the Regional Conservation Boards under Law No. 2863.

Application to the Ancient City of Notion

The ancient city of Notion, situated on the coast of the Gulf of Kuşadası in the Menderes district of İzmir Province, was initially registered as a Third Degree Archaeological Site in the 1980s. However, reflecting the site's significant historical value and recent discoveries, the İzmir No. 1 Regional Cultural Heritage Conservation Board recently revised this status. Following rescue excavations that revealed significant late antique structures and artifacts, the main site was officially elevated and re-registered strictly as a First Degree Archaeological Site (1. Derece Arkeolojik Sit Alanı) in early 2024, removing the prior third-degree allowance for localized development.[132]

As with all registered archaeological sites in Turkiye, any excavation, research, or physical intervention at Notion requires a formal permit issued by the Ministry of Culture and Tourism, pursuant to Article 10 of Law No. 2863.[133] This requirement governs all work currently conducted at the site: the ongoing excavation campaign led by the University of Michigan, which commenced in 2022 under a permit granted by the Ministry, is carried out in collaboration with Turkish university partners from Sinop and Adnan Menderes Universities. [134]

The domestic regulatory framework is further reinforced by Turkiye's international commitments. Turkiye ratified the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage on 16 March 1983, the same year that Law No. 2863 was enacted. Türkiye subsequently signed the European Convention on the Protection of the Archaeological Heritage (Valletta Convention, 1992) in 1999. The 2004 amendments to Law No. 2863 (Law No. 5226) were in part intended to harmonise domestic law with these international obligations, strengthening the role of the Regional Conservation Boards and introducing clearer provisions for the management and valorisation of heritage sites. [135] Any conservation and restoration proposal for the ancient city of Notion must therefore operate within this layered framework: the strict physical non-intervention standards set by its First Degree status under Law No. 2863, the decisions of the İzmir Regional Cultural Heritage Conservation Board, and the methodological principles established by the relevant international charters, above all the Venice Charter (1964) and the ICOMOS Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage (2003). However, despite the ongoing excavation campaigns and the site's stringent legislative protections, a comprehensive site management plan has not yet been implemented on the ground. Currently, physical preservation and visitor management strategies remain highly limited. The only tangible infrastructural intervention to date is the installation of protective fencing along the northern boundary of the site. The absence of a holistic management framework leaves much of the ancient city vulnerable to both ecological and human-induced degradation, highlighting a critical gap between legislative theory and practical application. To address this deficiency and build upon the site's rich archaeological context, the following proposals outline a robust, actionable conservation and site management strategy for Notion.

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131. Historically declared a Third Degree Zone in the 1980s, the tapu (land registry) annotation for the 3rd degree was officially removed, and the core site area was elevated and re-registered as a First Degree Archaeological Site (1. Derece Arkeolojik Sit Alanı) by the İzmir No. 1 Regional Cultural Heritage Conservation Board in March 2024 following recent discoveries.

132. Law No. 2863, art. 10. All excavation must be authorised by the Ministry of Culture and Tourism; unauthorised excavation carries criminal penalties under Article 74.

133. Notion Archaeological Project, University of Michigan, "About," sites. lsa. umich. edu/notionproject. Excavations, which resumed in 2022, are conducted in collaboration with Sinop and Adnan Menderes Universities.

134. Turkey ratified the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage on March 16, 1983. Turkey signed (but has not formally ratified) the European Convention on the Protection of the Archaeological Heritage (Valletta Convention, 1992) in 1999. See UNESCO World Heritage Centre: whc. unesco. org/en/statesparties/tr; Eres, "Changing Policies," Internet Archaeology 54.

7.2 The Design Approach: A Dialogue with the Archaeological Landscape

The primary objective of the design approach for Notion Ancient City is fundamentally evaluating it as a living archaeological landscape rather than just a city with collection of the ancient remains.[136] The relationship between the ancient ruins, its topography and the diverse flora can not be evaluated separately.[137] Over the centuries the ruins generated a great bond with the ecosystem and its botanical identity instead of having isolated architectural remains (Fig. 200). Besides, the ruin emboides a unique synthesis between nature and art where natural forces don't destroy but actively complete what the human built. Consequently, this site should not be treated as a sterile, over-designed, open-air museum, rather it should be significantly assessed with its broader territorial and ecological dimensions.[138]

This approach dictates maintaining the symbiotic relationship of ancient ruins and their ecosystem, which is carrying the authentic passage of time in the city to the present day. Therefore, the authentic value of the city has been acquired by its relationship with its living landscape.[139]

The design proposals offer to the visitors the historical patina wherein biological life of the site is not exclusively as a threat to be eliminated, it is a component of the archaeological spatial narrative. The intention of presenting the archaeological remains directly intertwined with the nature, allows visitors to have a natural experience while contextually protecting the ancient site.

In order to achieve this delicate balance, the entire design proposals are guided by the minimum intervention principles. The site management strategy ensures that visitors can safely explore and experience the ruin in its natural context. The guidance the visitors on the rugged terrain respect to the maintain their safe visit and the modern interventions establish a harmonic dialogue with the landscape. Ultimately, this comprehensive design intervention approach aims to ensure maintaining the structural, material integrity of archaeological remains with its integrity in landscape rather than sterilization of the remains from its natural context.[140]

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135. Emanuele Romeo, 'Il restauro dei siti e del paesaggio archeologico,' in Restauro architettonico: Teorie e metodi, ed. Marco Dezzi Bardeschi (Torino: UTET, 2012), 223–230
136. Tessa Matteini and Giuliano Volpe, eds., "Paesaggi di rovine, paesaggi rovinati / Landscapes of ruins, ruined landscapes," Ri-Vista: Ricerche per la progettazione del paesaggio, no. 2 (2014).
137. Simmel, 'The Ruin,' 379–384.
138. Riegl, 'The Modern Cult of Monuments,' 27–33.
139. Andrea Ugolini, ed., Ricomporre la rovina (Florence: Alinea, 2010), 7–22.



Figure 200. View of the ancient theater of Notion, illustrating symbiosis of ruin and vegetation carrying the authentic passage of time to the present day. Photo by author.

7.3 The Site Management

7.3.1 Fencing Strategy and Site Access Control

- **The Boundary Security Strategy**

  The partial fence along the northern border is insufficient to safeguard the ancient city from the anthropogenic hazards. In order to prevent unauthorized access and organize the security of the ruins, the proposal is extending the perimeter of the fence along the western and eastern edges of the site. However, this fencing proposal is determined to adapt to the natural topography of the site and respect the parcel boundaries and land ownership of the local community, also considering of the buffer zone to the ancient city.

- **The Utilization of Natural Topographical Barriers**

  The southern border of Notion is naturally secured by a steep cliff facing to the Aegean Sea, which restricts the access from the coastline. The steep cliff strategically utilized as a "natural topographical barrier". In order to preserve the authentic coastal silhouette it is not suggested to build the fences through this coastline. Besides, the fences along the western and eastern slopes are designed to terminate at the end of these cliffs, integrating with the existing natural topography.

- **Integration of the Baradan Bay Hiking Trail**

  On the eastern side of the city, a walking path used by both local and foreign hikers connects Baradan Bay directly to the outskirts of the ancient city. While site management aims to control access, completely closing this path or restricting hikers' access contradicts the area's ecological and archaeological landscape character; furthermore, it would conflict with the objective of making the ancient city welcoming to visitors. Therefore, the design proposes a route intervention: fences are arranged alongside the trail to channel foot traffic onto a single route, which prevent uncontrolled and unauthorized entry into the ancient city. Thereby, hikers and visitors are guided along a designated pathway that terminates directly at the controlled East Entrance, allowing them to continue their journey through the ancient city .

The site access organized on two strategic entry points in order to manage visitor access effectively while minimizing impact on the archaeological fabric :

- **The Main Entrance (West Harbour Gate):**

  Regarding the historical and urban context of the city, the primary visitor entrance is strategically redirected toward the ancient Harbour Gate on the western slope. The visitors arriving by car or as pedestrians from Ahmetbeyli roundabout primarily directed to the main gate. The visitors will be welcomed by the Information Pavilion positioned along the Hales River, directs the visitors to the primary visitor path. This pavilion serves as more than a just welcoming spot, it also represents the essential information panels regarding to the historical and archaeological background of the ancient city and the suggested walking paths through the visiting journey regarding to the ancient remains and site's landscape. These visitor guidelines regarding the suggested walking routes aim to ensure the visitor comfort throughout their journey while avoiding the pedestrian circulation away from the fragile ruins.

- **The Secondary Entrance (East Entrance)**

  The secondary entrance is strategically positioned to create connection with the site entrance with the Selçuk-Kuşadası regional highway. However visitors arriving by vehicle utilize a natural terrain pocket along the highway as a dedicated parking and drop-off zone. From this entrance point, the visitors experience shift to the pedestrian, following the walking path towards to the ancient site. Along this path, reaches to the junction where it splits into two distinct paths, one leading into directly to the ancient city, and the other one continuing toward Baradan Bay.
  In order to ensure the access control, "The Site Steward Node" is essential beside the fence strategy, as an observation and welcoming point is proposed at the separation point of the paths. This dual route configuration of the path integrates both highway arriving visitors and natural scape hikers into the cultural narrative without disrupting their natural flow.

- **The Custodians:**

  The Custodians are situated in this junction of the pathways as welcoming points. Besides the access control by the fence strategy, this welcoming point allows control of the visitor entry to the archeological site while allowing hikers free passage toward the bay. (Fig. 201)

Design Proposals on the Master Plan

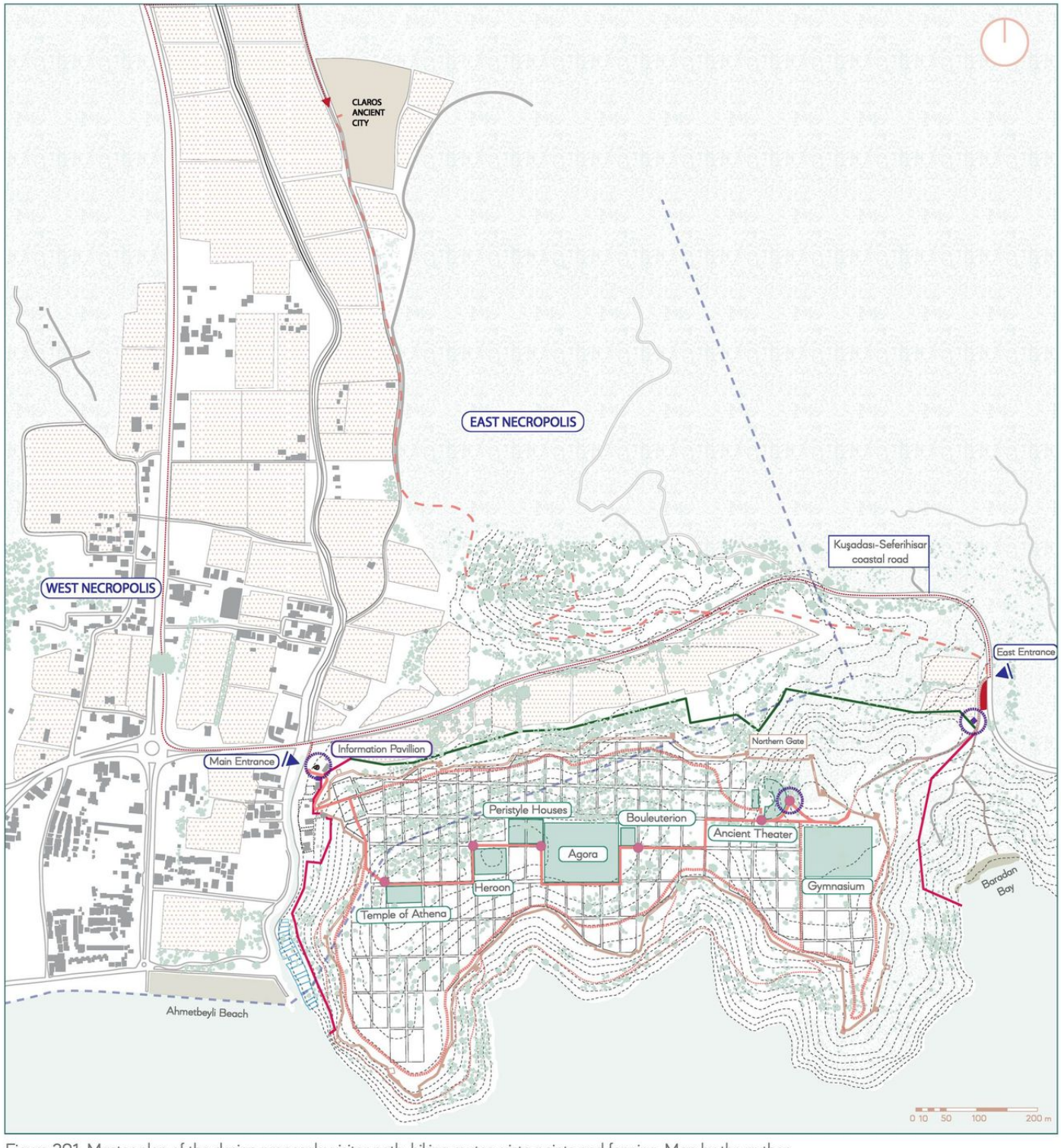


Figure 201. Master plan of the design proposals: visitor path, hiking routes, vista points and fencing. Map by the author.

Legend

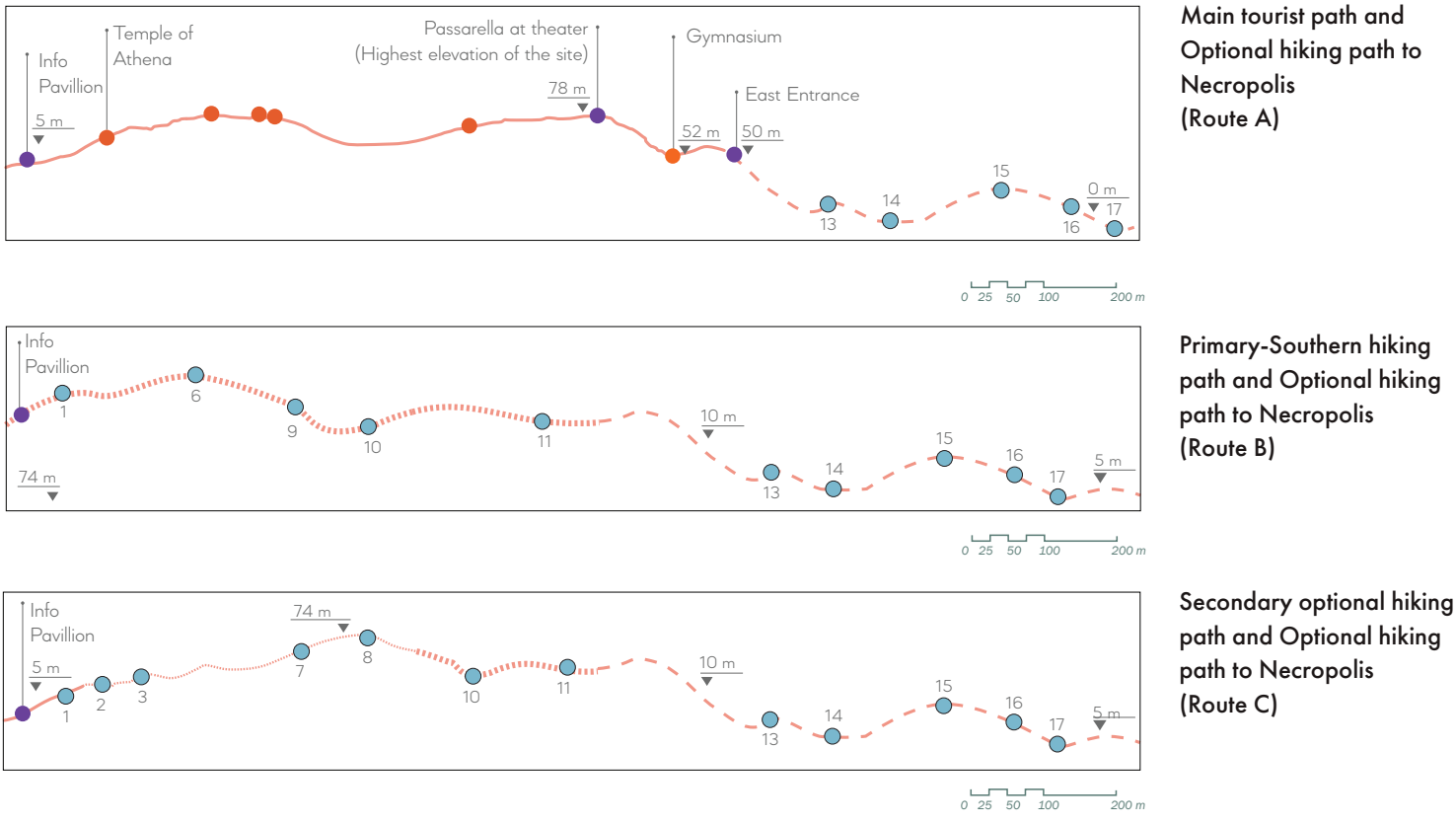
- Forest
- Agricultural Site
- Optional Hiking Path-to Necropolis
- To-Visit Cordons
- Remaining Fortification Walls
- Primary Visitor Path
- Primary Hiking Path
- Secondary Hiking Path
- Existing Fences since 2023
- New fence proposals
- Design Proposals
- Suggested Unpaved Parking
- Parcel Boundaries

7.3.2 Primary Visit and Hiking Path Proposals

The proposed Primary Visit Path aims to guide visitors safely through the site while respecting the topographical profile of the landscape. The route starts from the West Entrance (which is Harbour Gate in historical context), this path connects to the main public buildings in order on the site as the Temple of Athena, the Agora, the Bouleuterion, and the Theater. This route is proposed with respect to the topographical slopes of the landscape to ensure a safe walk. The proposal route aims to let visitors and hikers experience the archaeological landscape of the site, and prevents people from walking over fragile ruins. These visit paths are intentionally defined on the existing soil based path which has been naturally cleared from the invasive vegetation and compacted over the years by the local shepherds and their grazing sheep in order to minimize unnecessary extra architectural intervention, such as building a new pavement path. The embracement of this pastoral landscape provides a highly durable, naturally walkable route without introducing an artificial paving, hence serving as an active design approach for preventive conservation.

It is observed that the site has been used by the hikers due to its natural landscape. Thereby, the multiple hiking path routes that have been defined within the recorded hiking paths have been used for the hikers for a long time. While defining the hiking paths, it is considered that the visitors often get lost due to the absence of clearly defined route and signages. Significantly, this issue poses a direct threat to the preservation of the ancient city, since the hikers have been seen synthetic painting signs on the ancient remain stones and the trees, and utilizing the plastic tie materials to the trees in order to mark the routes. Therefore, minimalist signage will be installed along the hiking routes to guide the hikers without harming nature or disrupting the region's authentic and natural landscape. This Interpretive signage will be consist of pre-weathered and sealed Corten steel channels to prevent iron oxide runoff into the archaeological ruins, while visually match the natural color palette of the environment. (Fig. 203)

Slope Analysis and Topographical Accessibility of the Circulation Routes

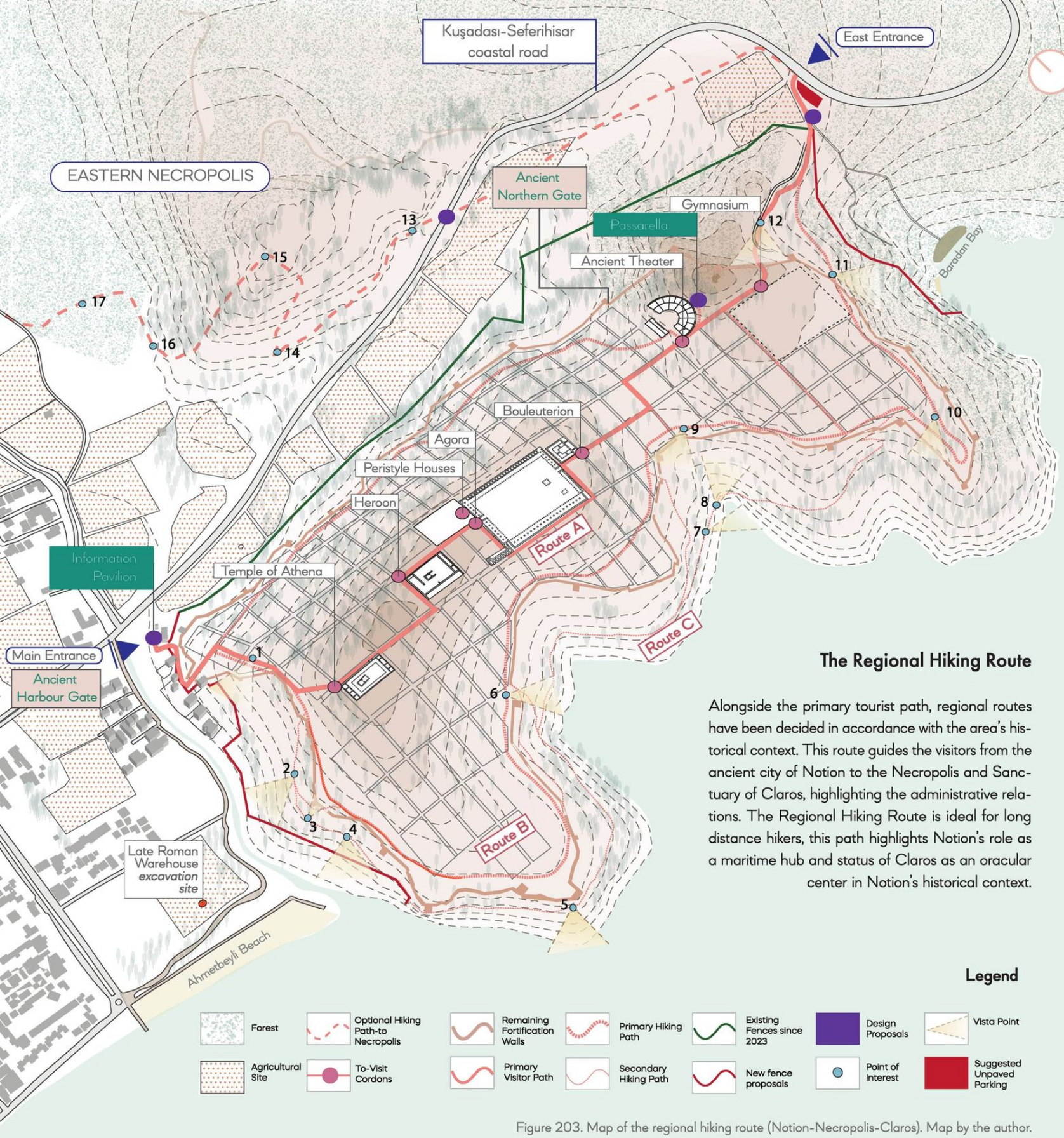


Main tourist path and Optional hiking path to Necropolis (Route A)

Primary-Southern hiking path and Optional hiking path to Necropolis (Route B)

Secondary optional hiking path and Optional hiking path to Necropolis (Route C)

Figure 202. Altitude Diagram of the hiking-route / visitor-experience data. Diagram by the author.



The Regional Hiking Route

Alongside the primary tourist path, regional routes have been decided in accordance with the area's historical context. This route guides the visitors from the ancient city of Notion to the Necropolis and Sanctuary of Claros, highlighting the administrative relations. The Regional Hiking Route is ideal for long distance hikers, this path highlights Notion's role as a maritime hub and status of Claros as an oracular center in Notion's historical context.

Figure 203. Map of the regional hiking route (Notion-Necropolis-Claros). Map by the author.

Vista points on Hiking Routes

Specific vista points (lookout points) have been determined along the hiking routes in order to enhance the perceptive experience of the site (Fig. 204). These observation points were developed as a response to the hikers to safely seek out panoramic viewpoints across the steep terrain of the site.

Based on the spatial evaluations during the site visit, these vista points strategically determined along safe and accessible segments of the routes. The primary objective is allowing to visitors to have a fully experince the scenery of the Aegean Sea and the archaeological landscape.



1- Gate Stairs on the fortification wall entrances



2- Hales River meets Aegean Sea



3- Mortared Spolia repairs of the fortification walls (Roman/Late Roman Period)



7- A view overlooking the western promontory of Notion



8- A view overlooking the western slope of Notion



9- A view from the secondary hiking path, looking east toward the ancient city of Ephesus



13- The entrance path to the northern necropolis, looking towards to the Notion Ancient City



14- A rock-cut tomb in the necropolis



15- Remains of rock-cut stairs in the necropolis

Figure 204. Vista points along the hiking routes. Photographs by the author.

Furthermore, these observation nodes enhance the archaeological landscape experience and its rich Mediterranean biodiversity. The vista points establish a visual corridor connecting Notion with Sanctuary of Apollo at Claros, and the ancient metropolis of Ephesus, representing the city's historical context.

At the urban scale, these viewpoints captures the visitor-s attention on distinct architectural remrants, such as the remaining ancient steps and the fortification walls repaired with ancient spolia. Finally, the viewpoints overlook to the Necropolis, allowing hikers to explore vast funerary traditions of the ancient city.



4- A panoramic view overlooking Ahmetbeyli Beach and the point where the Hales River meets the Aegean Sea



5- One of the promontories of Notion, featuring the visible remains of the ancient fortification walls



6- A scenic view overlooking Baradan Bay from the eastern side of the ancient city



10- A view overlooking the western promontory



11- A view of Baradan Bay



12- The eastern gate of the fortification wall



16- Wall remains within the necropolis



17- Rock-cut tombs



18- Sanctuary of Apollo at Claros

Figure 205. Vista points along the hiking routes. Photographs by the author.

Interpretive Signage Proposal

The proposed interpretive signage and wayfinding system along the hiking routes are designed for the navigational assistance, it is conceived as fundamental necessity for the conservation of the archaeological landscape. An archaeological site like Notion, is not a collection of isolated ruins, but a symbiosis between architecture and the natural environment. In order to preserve the *Genius Loci* (spirit of the place), the proposals must guide the visitor's experience the authentic patina time that characterizes the site.

At present, the absence of a clearly defined wayfinding system causes hikers to lose their orientation within the tough topography of the site. This disorientation generates improvised and destructive marking practices: visitors have been documented tying plastic strips to tree branches and applying synthetic paint directly onto ancient masonry and tree bark in an attempt to create their own route guidance. These ad hoc interventions constitute a direct threat to both the biological integrity of the vegetation and the material authenticity of the archaeological remains, as synthetic paints chemically interact with the stone surface and accelerate its deterioration. A legible, site-specific trail marker system addresses this problem; when visitors are provided with clear navigational guidance, the impulse to improvise disappears. Directing the flow of visitors through a coherent wayfinding network eliminates these destructive marking traces and guides the foot traffic away from the most vulnerable archaeological zones. Furthermore, lightweight marker posts are proposed along the routes, designed to cause minimum disturbance to the underlying archaeological stratigraphical layers (Fig. 206, 207).

Current State

Trail Marker Proposal



Figure 206. Design proposal for the hiking trail markers. Photograph and collage by the author.

Current State

Trail Marker Proposal



Figure 207. Design proposal for the hiking trail markers. Photograph and collage by the author.

7.4.1 The Information Pavilion

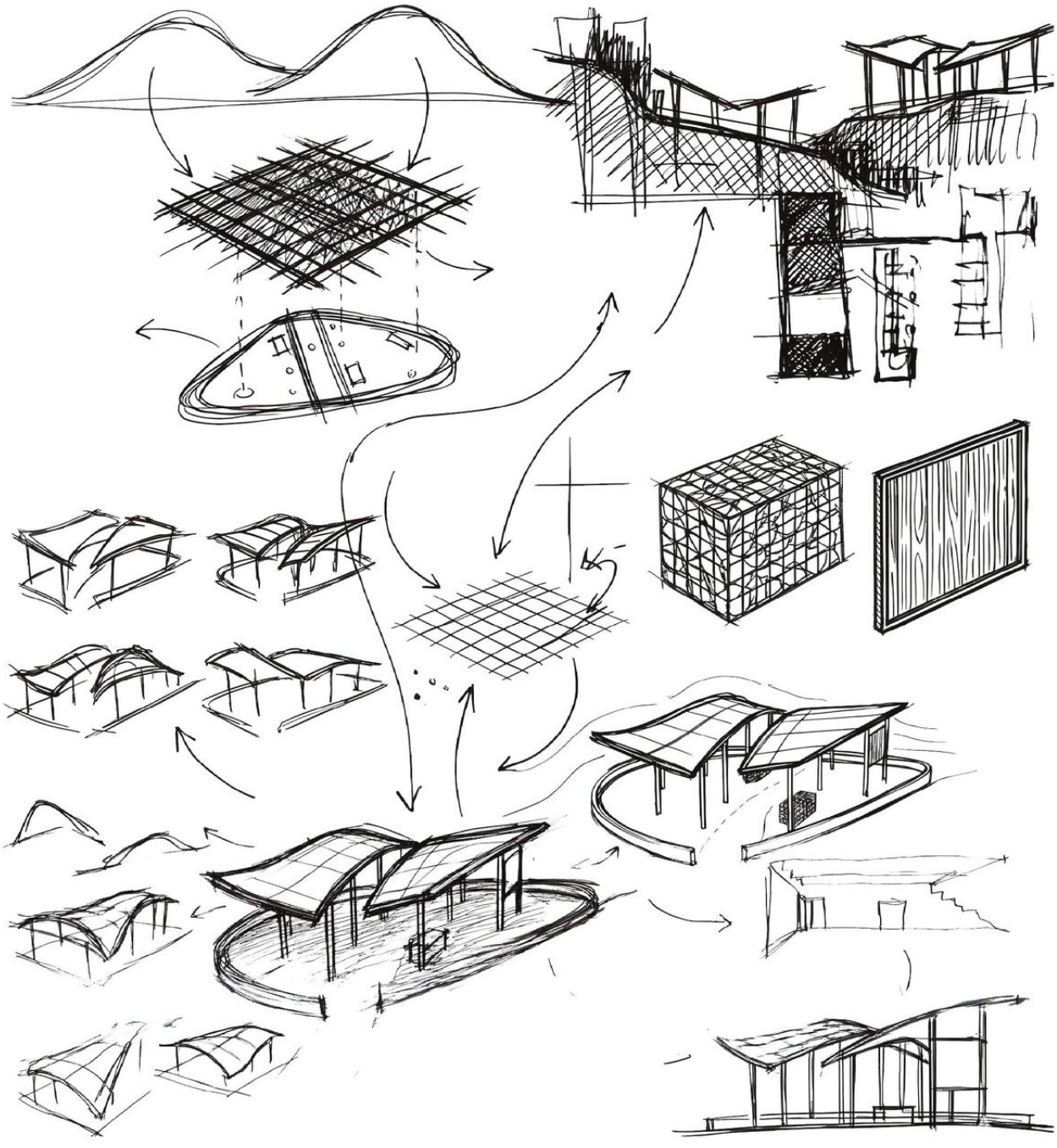


Figure 208. Hand sketches for the information pavilion. Sketches by the author.



Figure 209. Key plan locating the Information Pavilion and the *To-Visit Cordons*. Map by the author.

Information Pavillion

To-Visit Cordon

Theater Passarella

The primary goal of the architectural intervention proposals for the ancient city is to introduce the site to visitors through well-defined interventions and guide them to experience the site's character. Such proposals (Fig. 209) are developed with a sensitive approach to the site's archaeological stratigraphy, rejecting any visual or material mimicry that might compete with the ancient ruins. Furthermore, these architectural proposals reject the use of permanent foundations on the site. This approach ensures the protection of unexcavated archaeological layers and the living ecosystem while fulfilling visitors' needs.

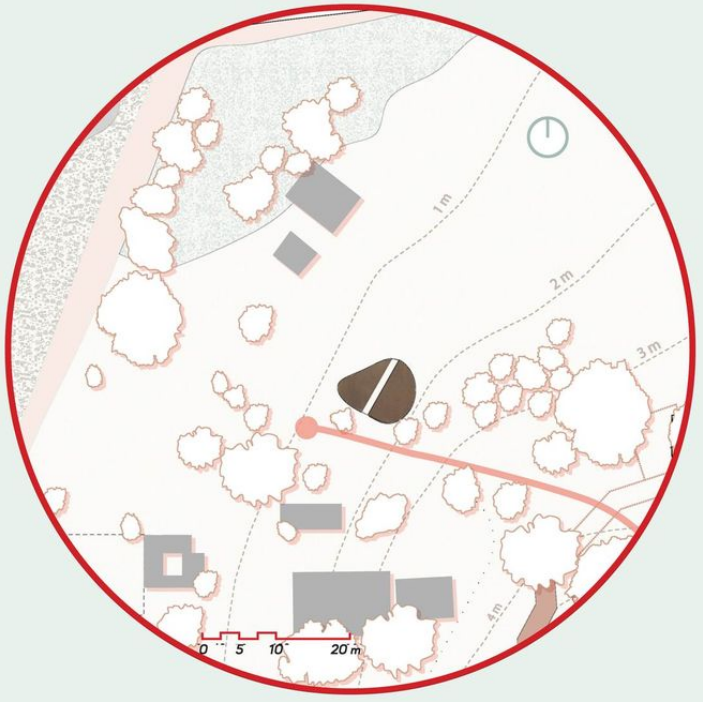
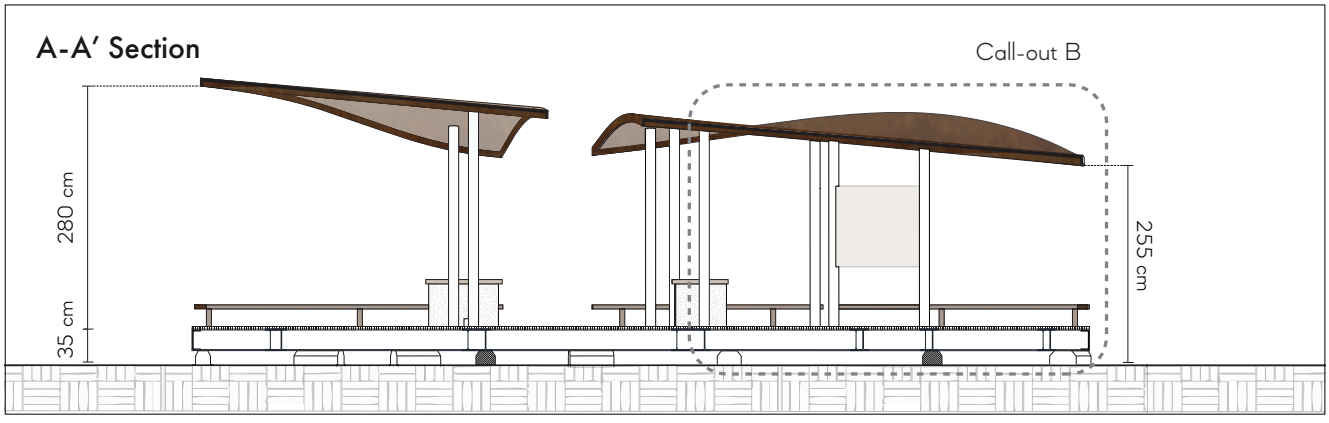


Figure 210. Plan of the information pavilion. Drawing by the author.



Figure 211. Current state of the area with information panel and the proposed location of the Information Pavillion (above) and the elevation of the Information Pavilion (bottom) by the author.

The Information Pavilion is a welcoming structure for the visitors to continue their journeys from the western gate to the paths. It is situated outside of the fortification walls of the city' however it provides the site maps, route directions and the historical context of the city. The design of this cover is based on Notion's topography and its Hellenistic grid urban planning. Its roof form has been inspired from the topographical feature of the two promontories that define the coastline of the city. The roof is designed with two separate canopies, additionally its divisions reflect the street divisions of its ancient grid planning. Besides, its two separated canopy roof also serves its crucial structural purposes.



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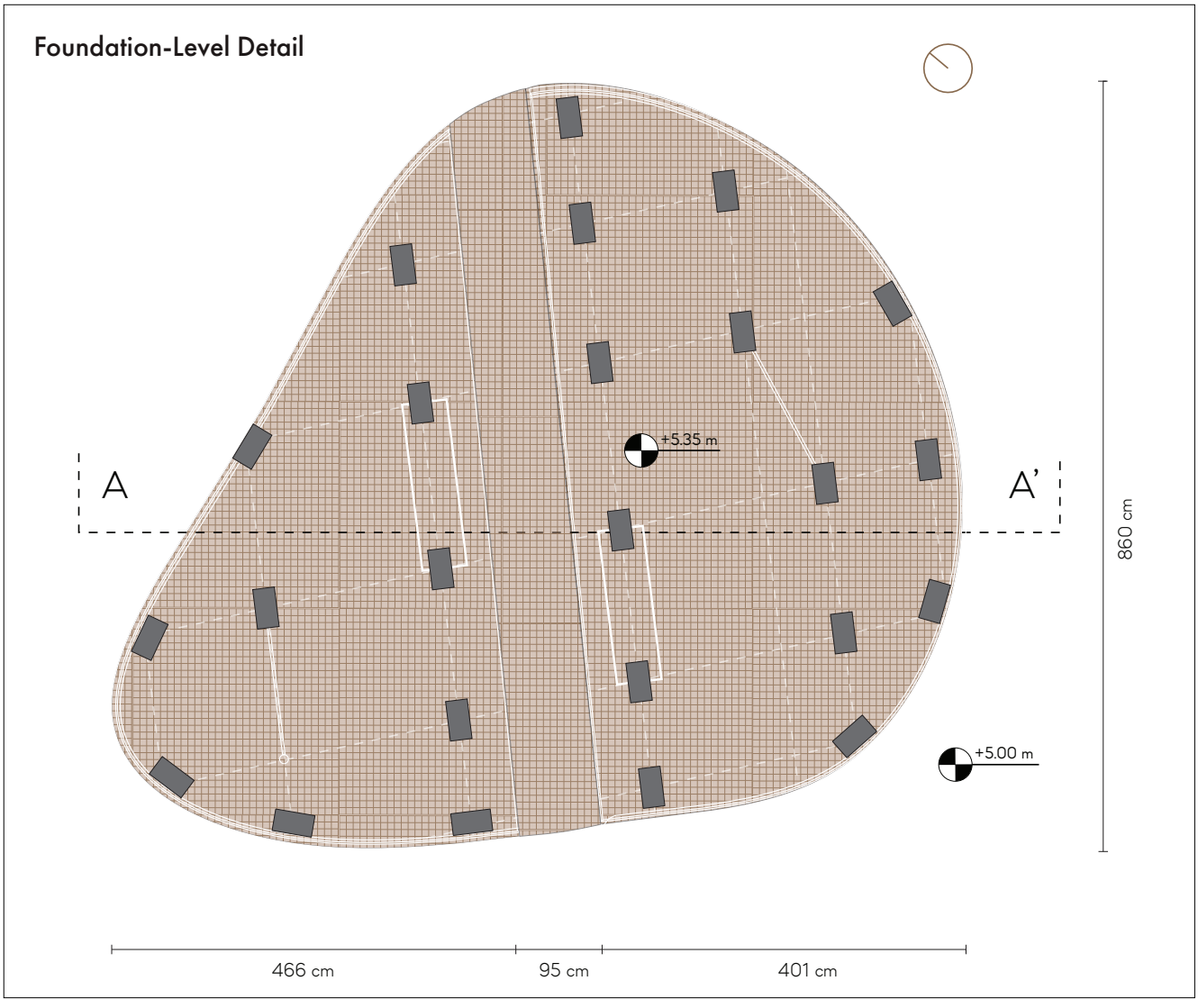
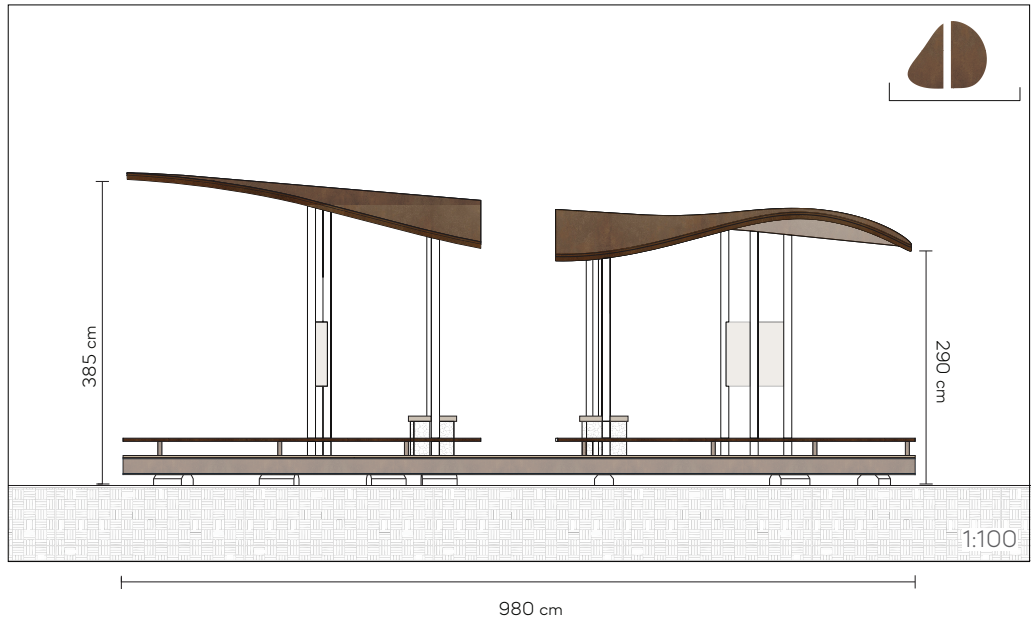


Figure 212. Plan and section of the Information Pavilion. Drawing by the author.

1:100

Front Elevation of the Pavilion



Side Elevation of the Pavilion

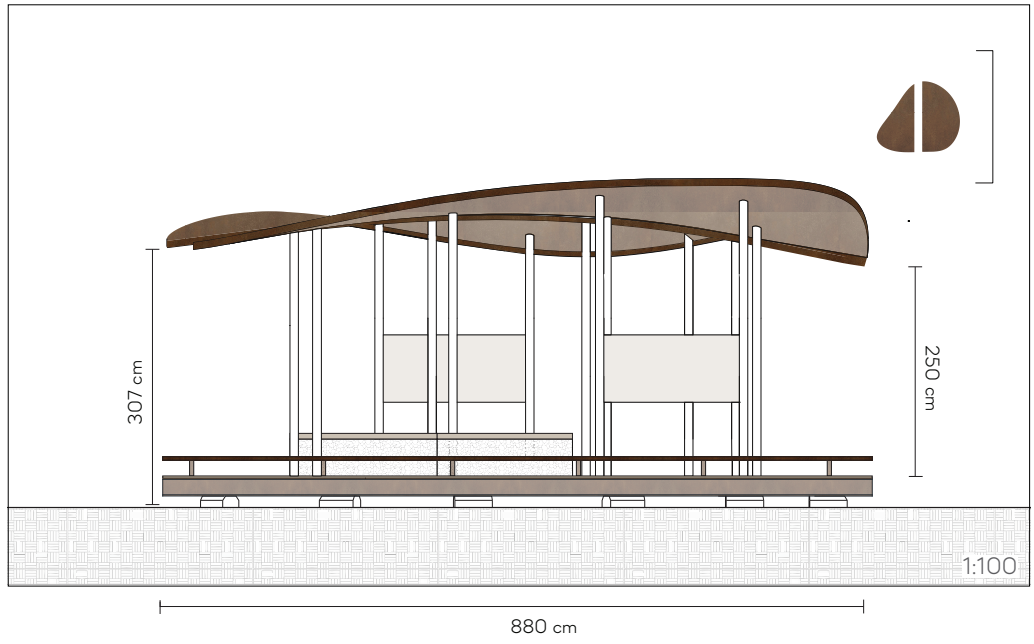
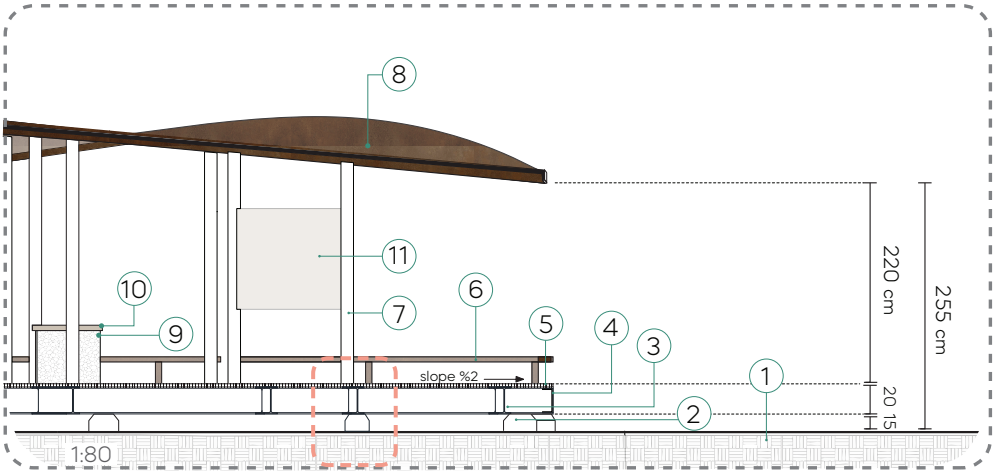


Figure 213. Front and side elevations of the Information Pavilion.
Drawings by the author.

Call-out Detail Section B



1. Earth
2. Precast Concrete Feet
3. IPE 200
4. C channel 180
5. Pre-weathered Corten grid
6. Preweathered sealed corten steel
7. Hollow section CHS d200
8. Sealed preweathered corten steel
9. Gabion seating box
10. Wooden deck
11. Corten Information panel

Figure 214. Steel deck and construction details of the Information Pavillion. Drawing by the author.

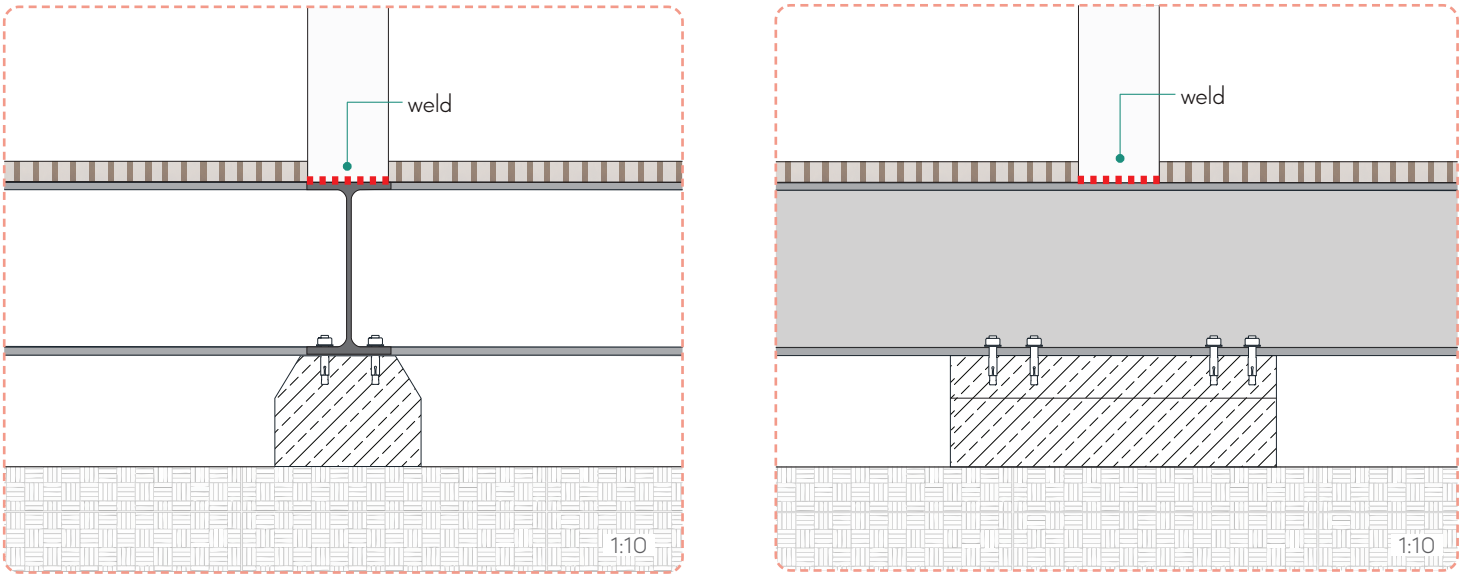


Figure 215. Foundation/surface-mounting details, front view (left) and side view (right) of the Information Pavilion. Drawing by the author.

Non-Invasive Foundation System

The pavilion utilizes a surface-mounted foundation in order to avoid any disturbance on the archaeological stratigraphy layers. The roof geometry generates a "sail effect" due to the strong wind or lateral loads, thereby the structure is anchored by individually placed concrete ballasts connected with the steel I beams, which supports the elevated steel platform. This interlocking system provides stability against lateral forces with no excavation. Furthermore, two separate parts of the canopy roof significantly reduces the leverage effect of the lateral loads acting on the pavilion. The canopy is constructed utilizing pre-weathered and sealed Corten steel. Hence, this material preference ensures that the rust stains do not contaminate the soil and the remains.

7.4.2 "To-Visit" Cordons



Figure 216.View of the site at the To-Visit Cordon location. Render by the author.

The way to convey the symbiotic relationship between nature and ruin to the visitor at Notion runs through a minimal intervention placed beside the monument. Accordingly, the information elements developed here aim to bring the visitor into direct yet respectful proximity with the monument, without physically penetrating the archaeological fabric. While potential remains beneath the surface are protected, the trace left above ground is designed to be reversible and to gradually integrate with the landscape over time.

"To-Visit" Cordons and panels are strategically placed on the specific monuments of the site along the primary tourist path that introduces their historical and architectural information (Fig. 216). These informational cordons encourage visitors to pause, allowing visitors to observe and inform about the monuments. The deep excavation is avoided and the cordons anchored by non-invasive diamond piers to protect the potential subsurface remains. The material specifically selected pre-weathered Corten steel chemically sealed without polluting the soil base.

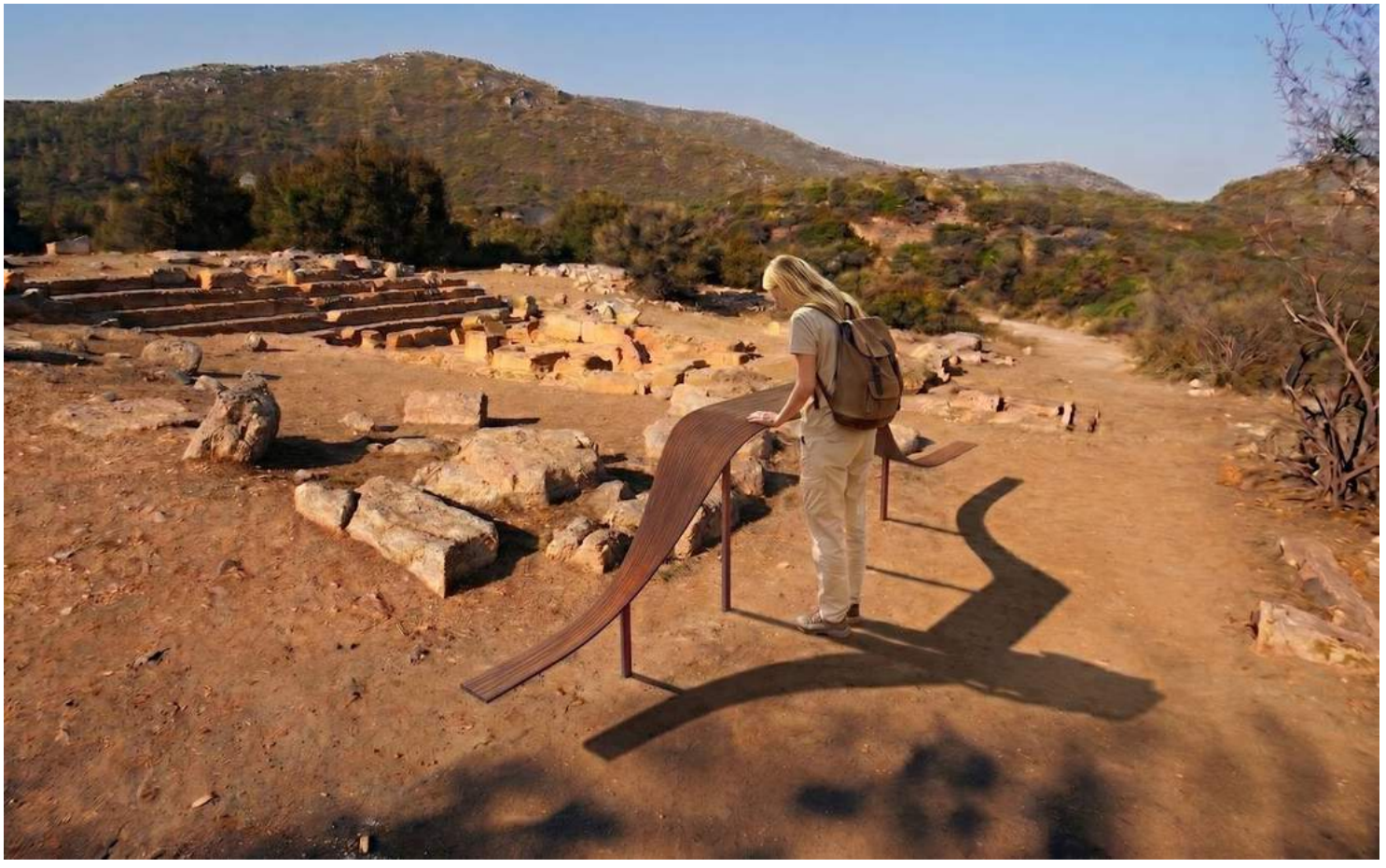


Figure 217. To-Visit Cordon in front of Bouleuterion. Render by the author.

The information stands placed front of every civic monuments, along the east-west ridge which functioned as the main street axis throughout the ancient city's history. It is currently proposed to place on the main visitor path (Fig. 217), therefore *To-Visit Cordons* rise and gradually fade into the historical landscape along the main visitor path to truly experience the traces of history.

The civic monuments where the To-Visit Cordon is located:

- Temple of Athena
- Heroon
- Peristyle House
- Agora
- Bouleuterion
- Theater's Passarella
- Gymnasium

To-Visit Cordon Plan and Elevation

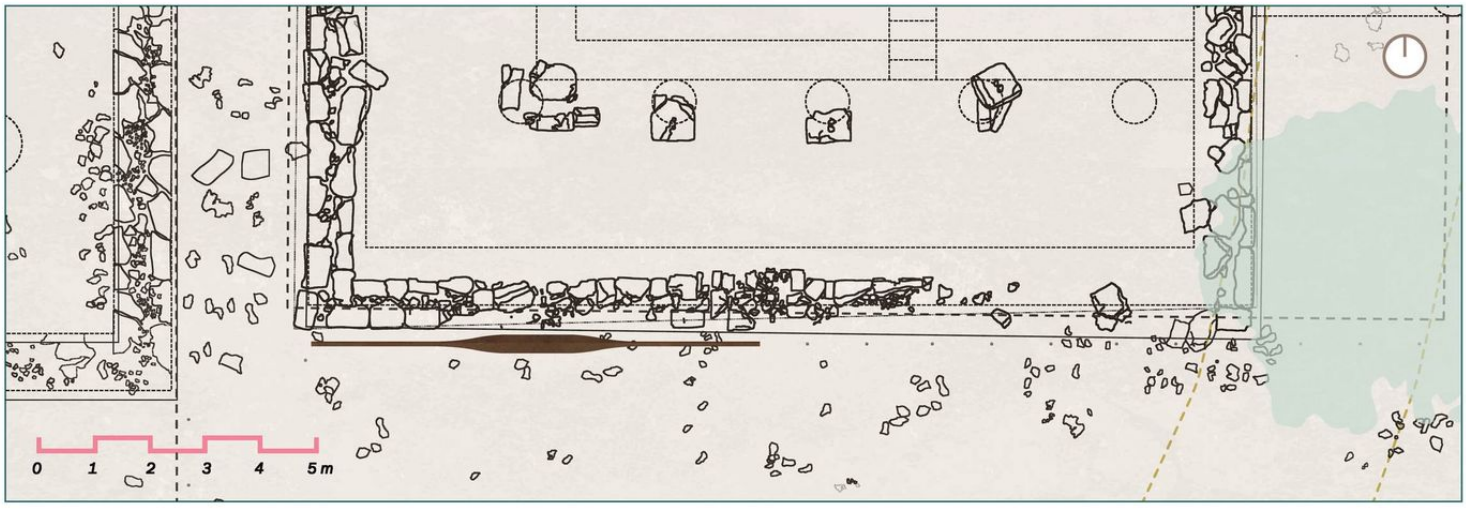
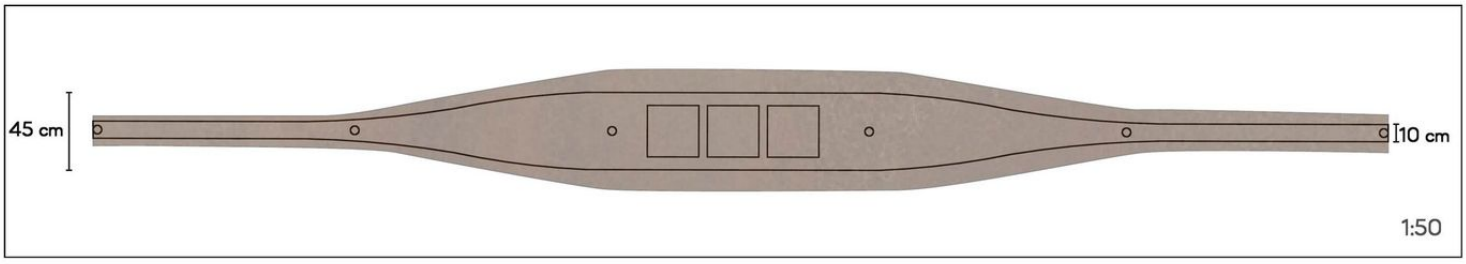


Figure 218. Plan of To-Visit Cordon located at the front of Bouleuterion Drawing by the author.

Cordon Plan



Cordon Elevation

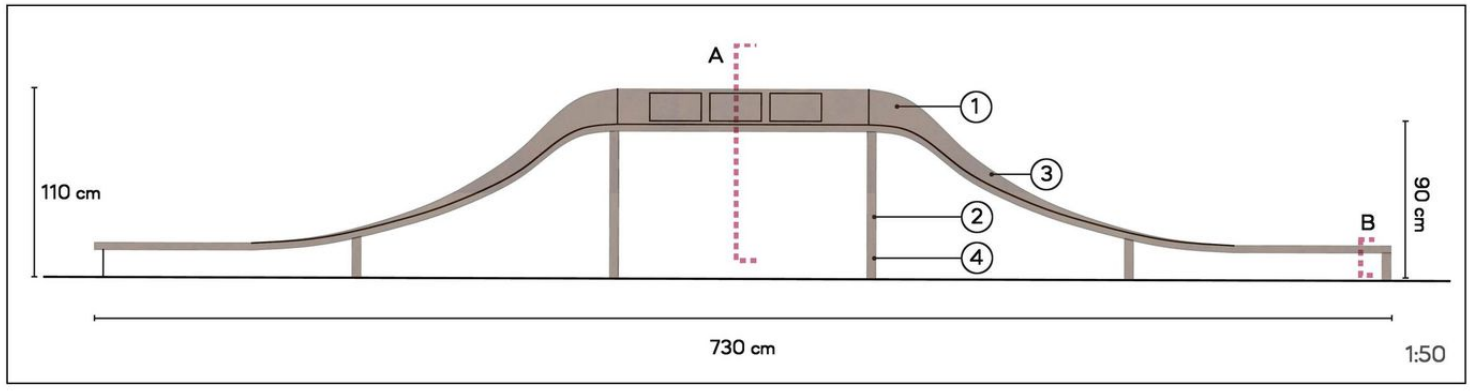


Figure 219. Plan(above) and elevation(bottom) of To-Visit Cordon drawings by the author.

Section A

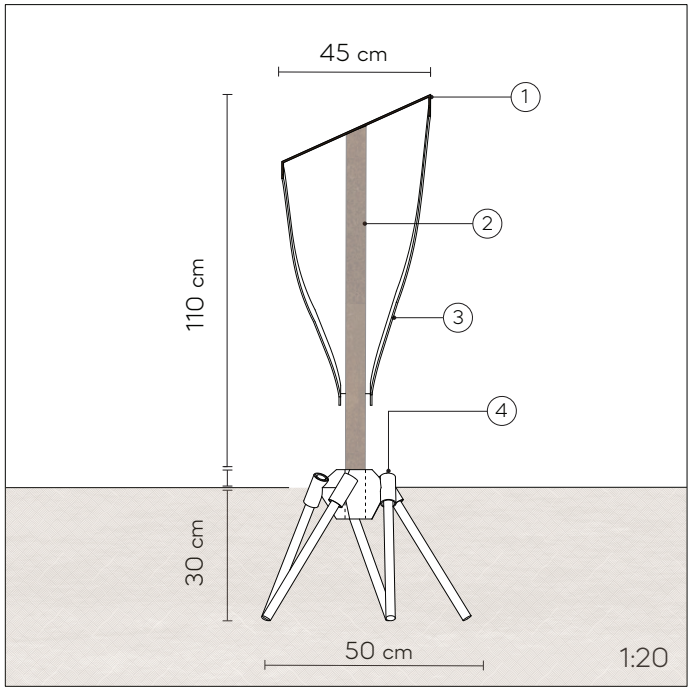


Figure 220. Construction section and diamond-detail detail of the To-Visit-Cordon. Drawings by the author.

Section B

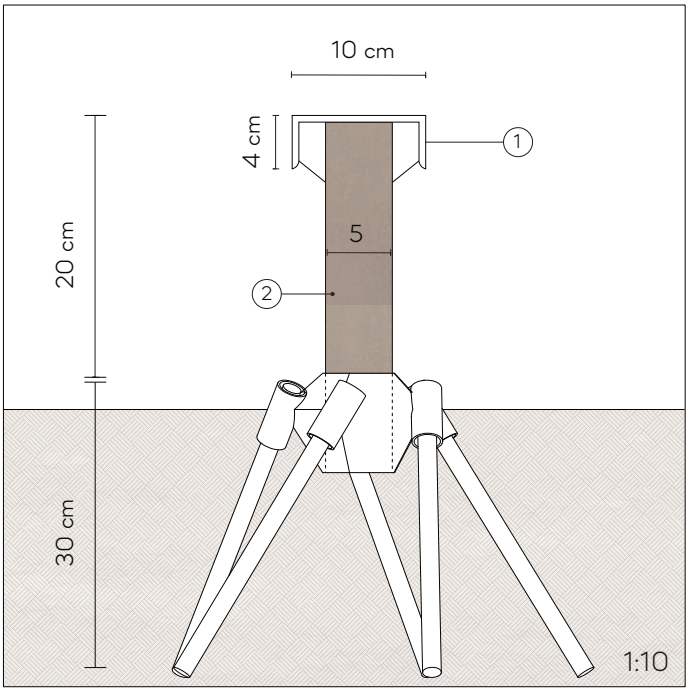


Figure 221. Construction section and diamond-close detail detail of the To-Visit-Cordon. Drawings by the author.

The implementation of Diamond Pier system has been selected as the structural base for mounting the to-visit cordon. The prefabricated system eliminates the need for the extensive excavation necessity. Thereby, the archaeological stratigraphy remains completely undisturbed, and allows the structural loads of cordons to be safely distributed and transmitted while preserving the physical integrity of the archaeological sublayers.

The main objective of utilization the pin foundation guarantees not disturbing the potential future archaeological data without leaving a permanent deep impact on the landscape. Consequently, the stands act as a guide for the visitors rather than an invasive threat to Notion's heritage, by safeguarding the yet-undiscovered and unexcavated historical layers (Fig. 218-221).

Components of the stand

1. Pre-weathered and sealed Corten Steel Channel
(to prevent iron oxide runoff on archaeological ruins)
2. Steel Stud
3. Custom Fabricated Corten Bent Metal
4. Diamond Pier, custom size 30 cm
5. Soil layer

7.4.3 Theater Pasarella

The structural integrity of the cavea has been notably challenging among the all civic monuments in the ancient city. The seating blocks, already weakened, cannot safely bear the concentrated load of visitor movement. Allowing visitors to climb directly onto the theater stones therefore poses an irreversible risk to the remains. For this reason, a pasarella is proposed to elevate and redirect the visitor circulation above the cavea, enabling the experience of the theater without direct contact with the structurally vulnerable archaeological fabric. The pasarella is not conceived as a barrier that separates the visitor from the site, but as a threshold that mediates the encounter between the human presence and the ruin (Fig. 222, 223).

By proposing an elevated the circulation above the cavea, the proposal acknowledges the existing symbiosis between the archaeological remains and the vegetation as a constitutive character of the site, rather than a problem to be corrected. The visitor is thus invited to observe this coexistence from above; perceiving the ruin not as a restored monument, but as a living landscape shaped by time, biology, and memory.

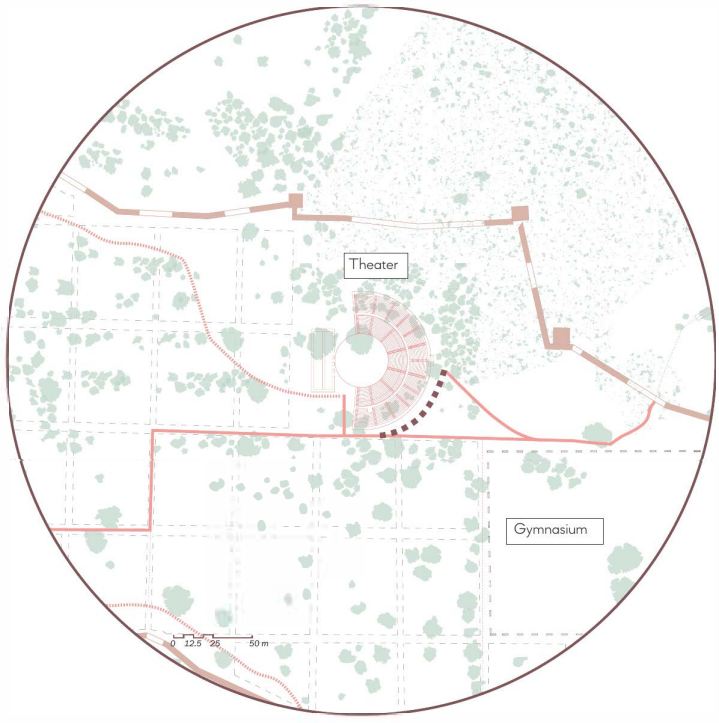
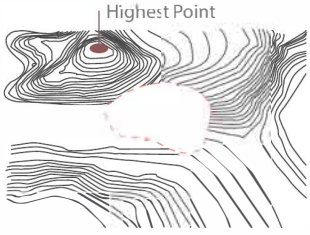


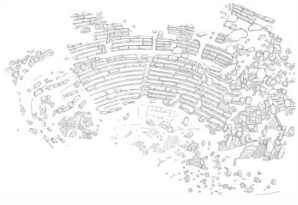
Figure 222. Plan of the theater with pasarella. Drawings by the author.

1- Topography



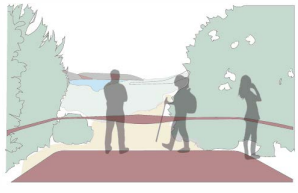
The rugged terrain of the theater presents a significant challenge for the visitors. The proposed passarella are designed to adapt the safe and comfortable pedestrian circulation through the high eastern promontory while avoiding the live load flow on the structurally unstable cavea blocks.

2- Vulnerability



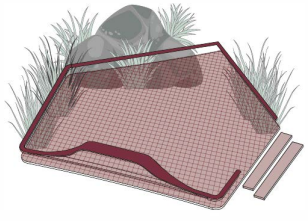
The ancient remains at theater exhibits high intrinsic vulnerabilities due to their disintegrated cavea structure. The lackness of the designated path led the visitors frequently to climb up to vulnerable seating stones. The elevated walkway ●assarella● guides the foot traffic awat from the ruins, preventing structural dislocation of the cavea remains.

3- View



The *pasarella* positioned the theater's steep topography to enhance the panoramic vista experience of the visitors through the end of their site visiting journey in the ancient city. The elevated walkway are strategically aligned to function as observation platforms, guiding the visitors to a perspective experience of the archaeological landscape.

4- Material and Construction



The *pasarella* is designated as lightweight structures that touch the ground lightly, avoiding deep destructive foundations that would irreversibly damage the underlying archaeological stratigraphical layers. The materials as pre-weathered and sealed Corten steel has been used for the *pasarella* that blends harmoniously with the site's natural color palette.

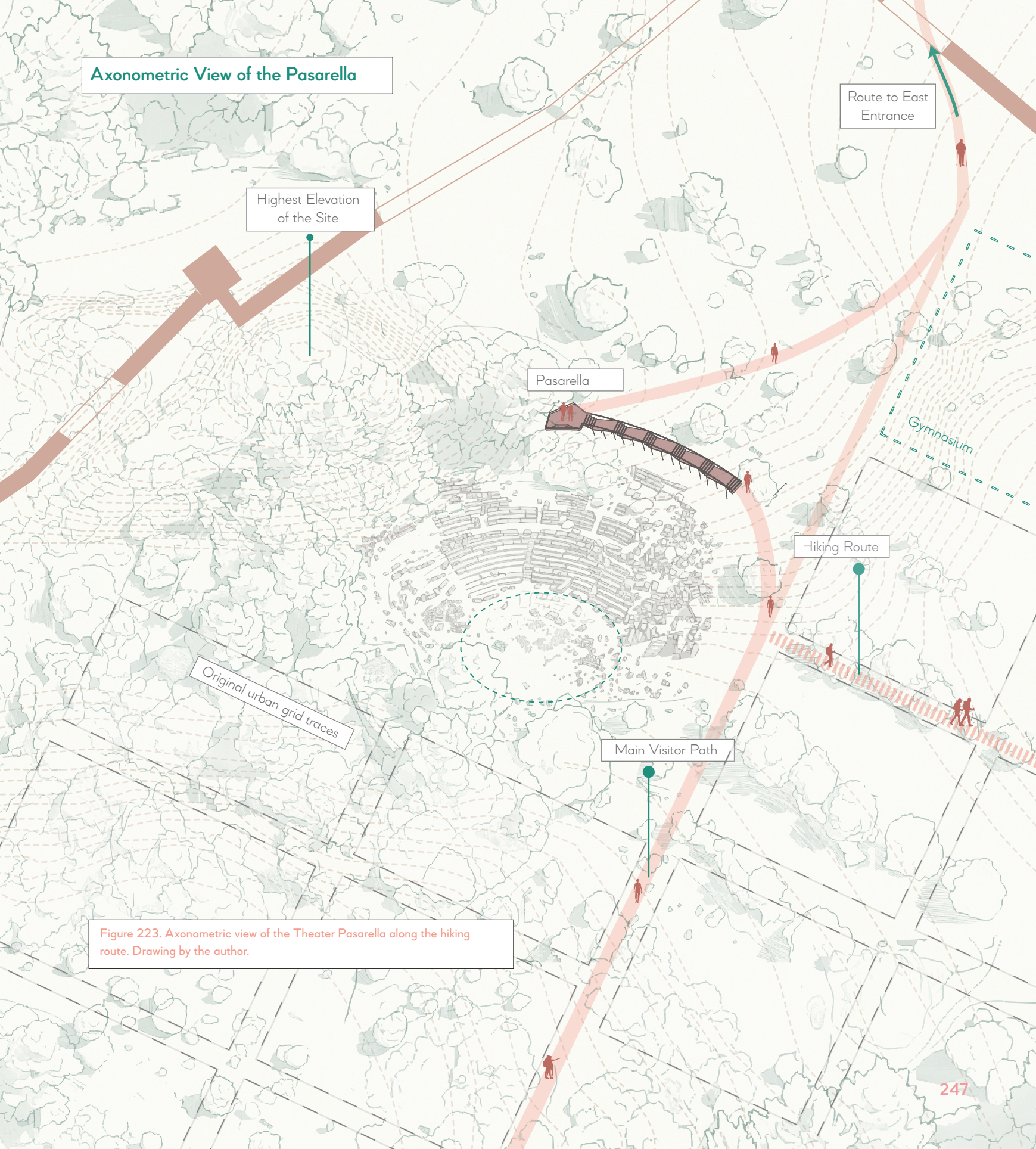


Figure 223. Axonometric view of the Theater Pasarella along the hiking route. Drawing by the author.

Theater Pasarella Masterplan

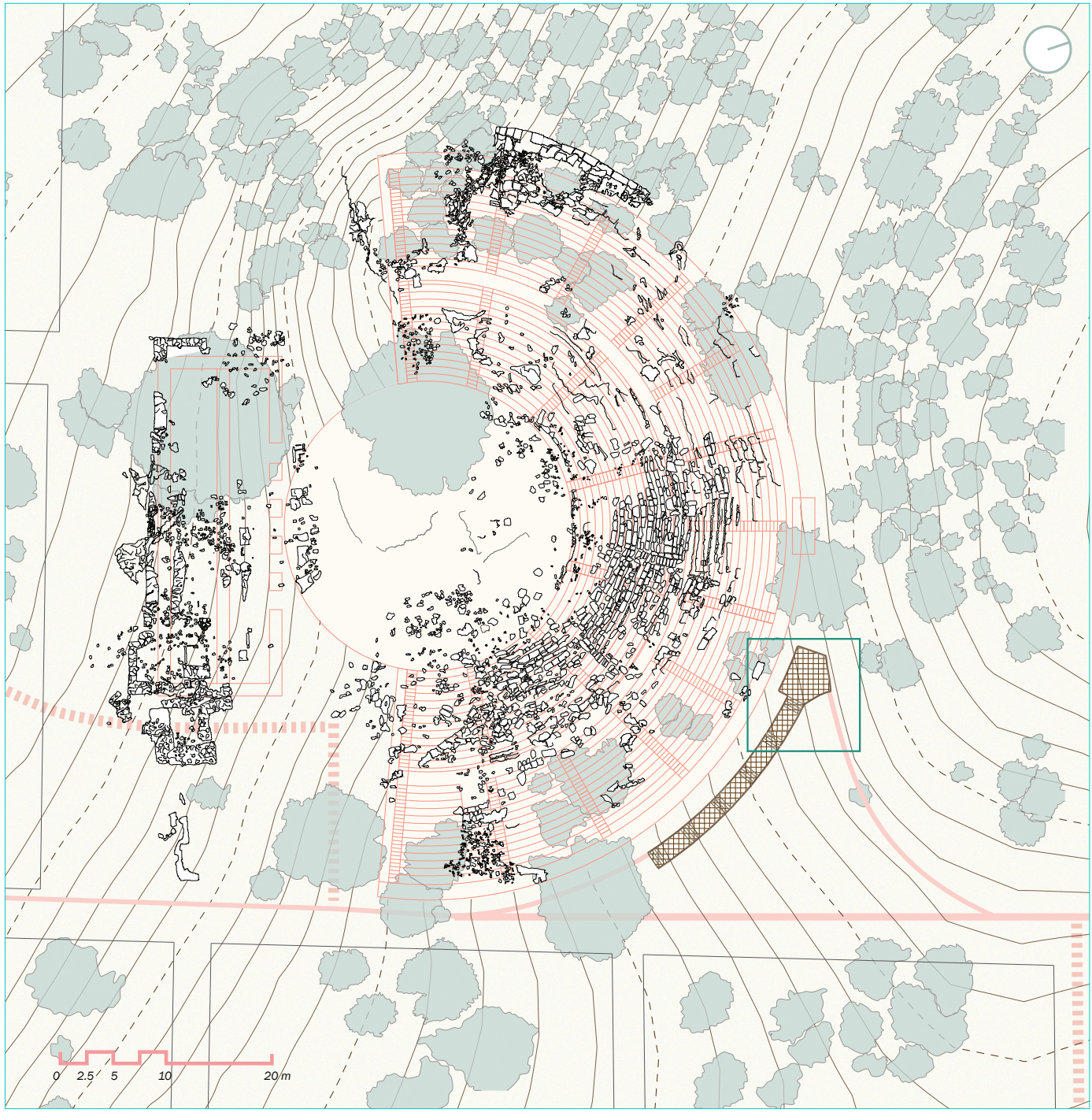


Figure 224. Plan of the theater with overlay of the reconstructed plan. Drawings by the author.

Theater Pasarella Masterplan

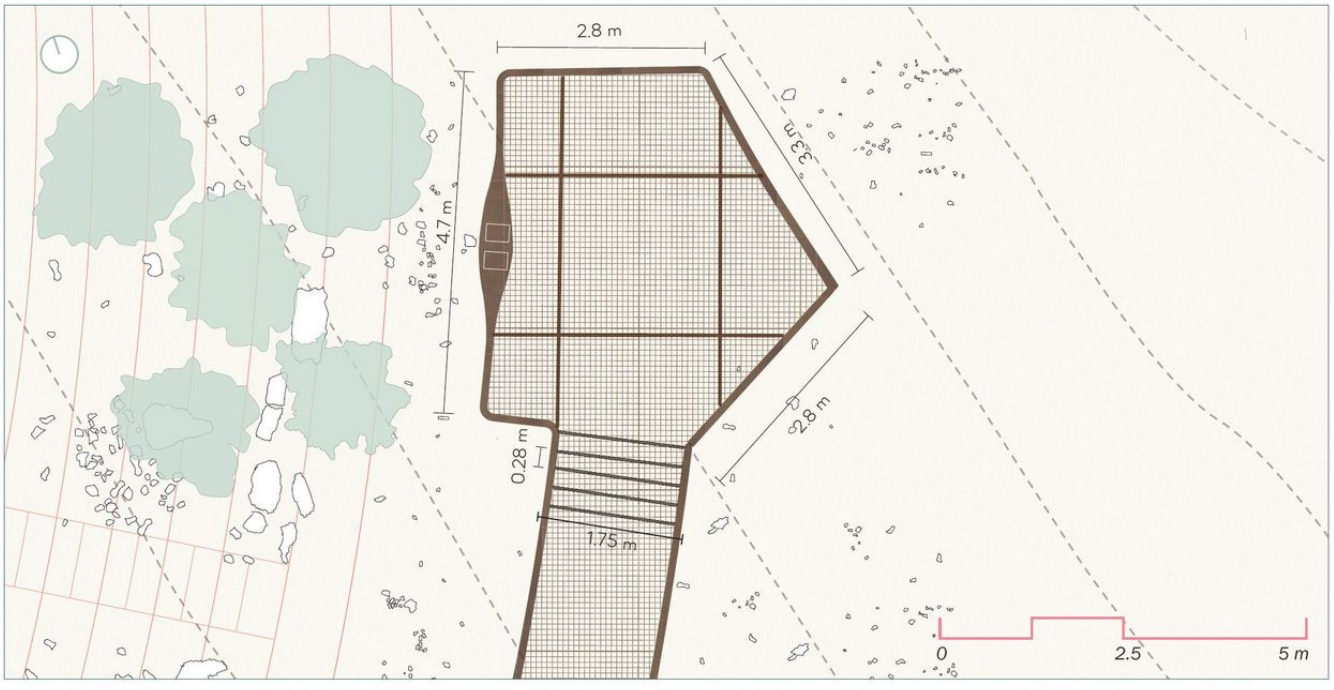


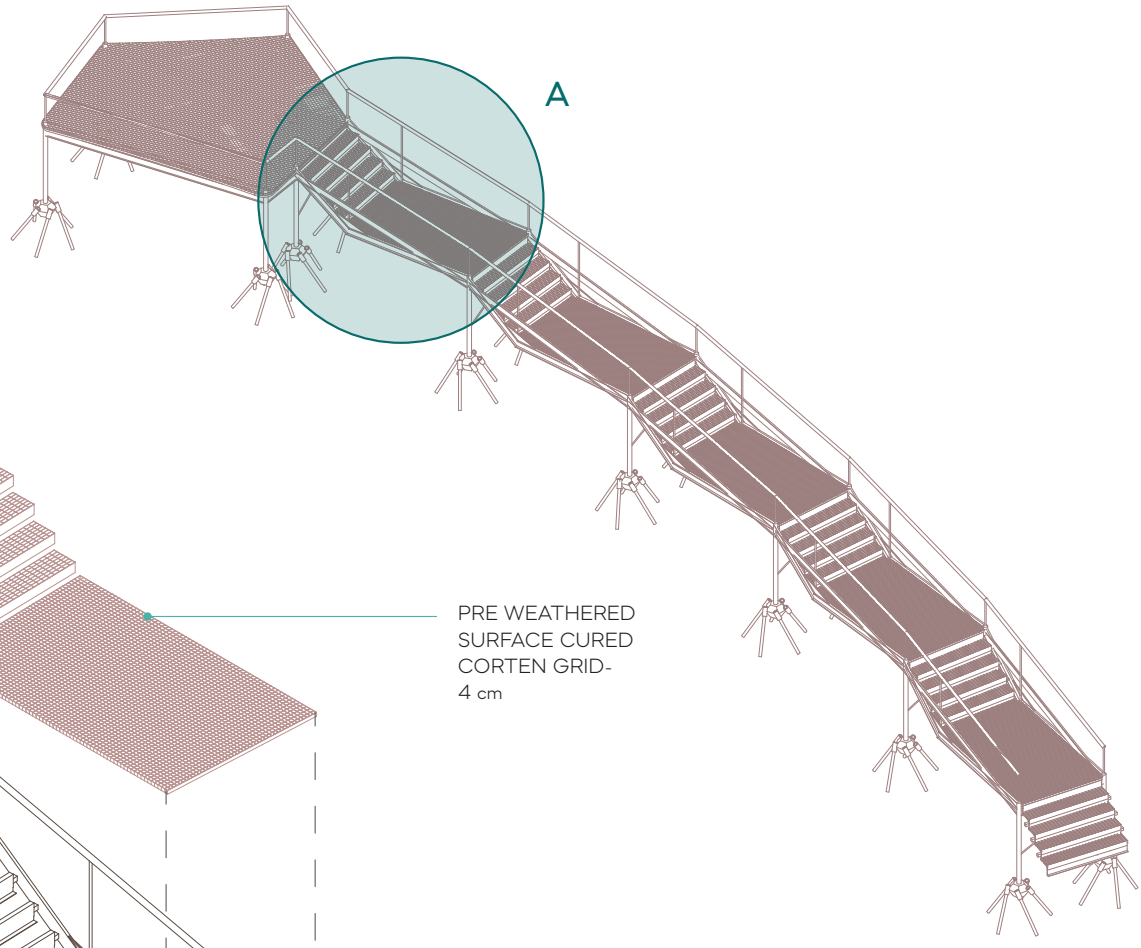
Figure 225. Plan of Pasarella. Drawings by the author.



Figure 226. Render of Pasarella. Render by the author.

Axonometric Construction Details of Theater Pasarella

Pasarella
Axonometry



Detail A

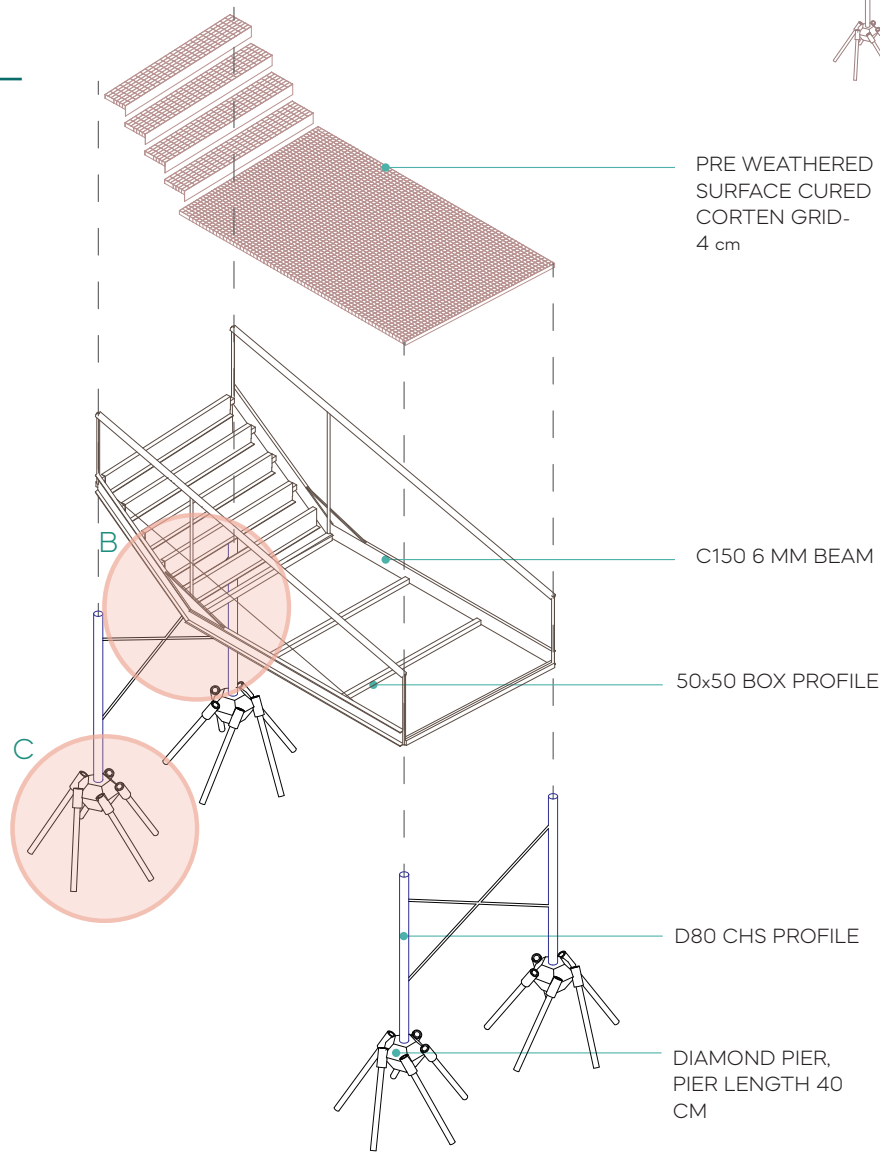
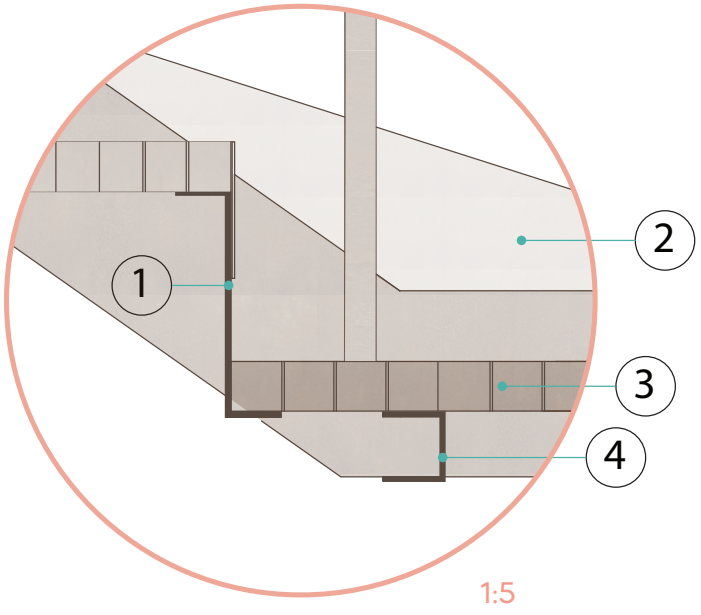


Figure 227. Axonometric construction details of the Theater Pasarella. Drawing by the author.



Render of Passarella

Detail B

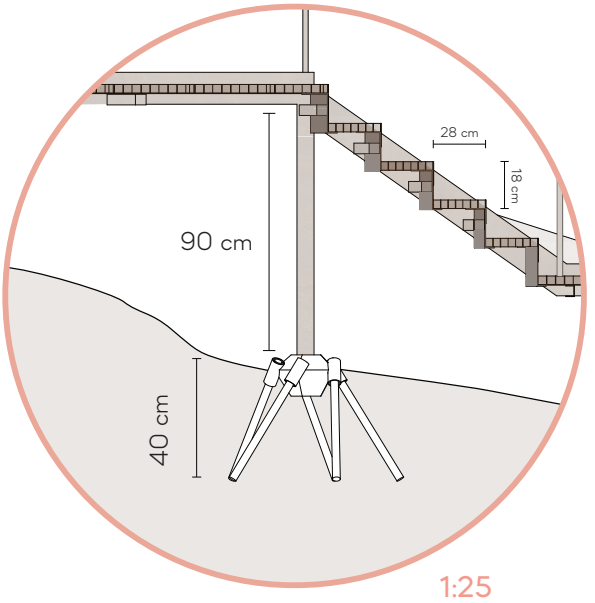


1:5

1. Z channel-3 mm thickness

2. Reinforcement flag-10 mm thickness

Detail C



1:25

3. Corten grid-4 cmm

4. C channel-60 mm x 3 mm thickness

Interpretive Panels on the Theater's Passerella

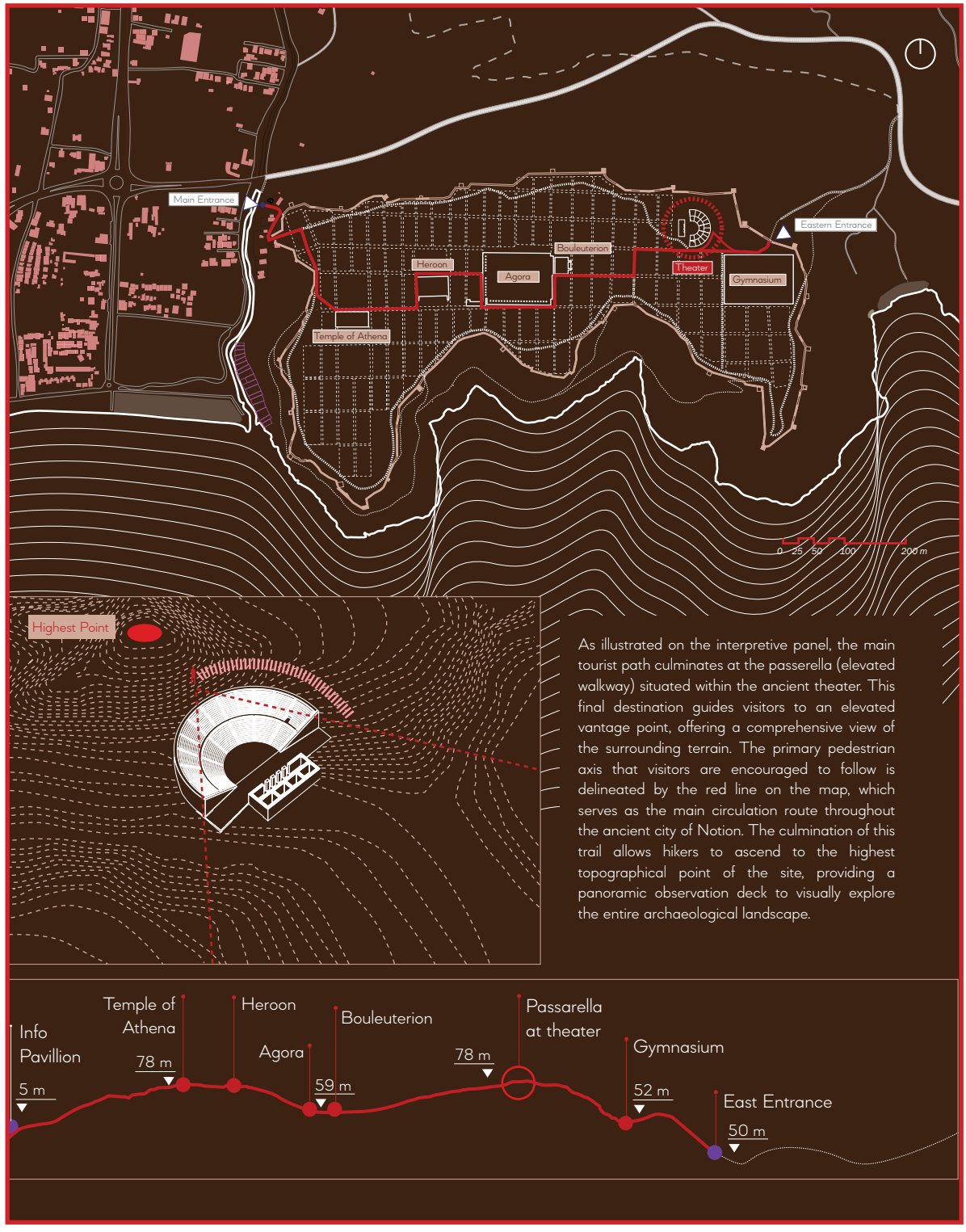
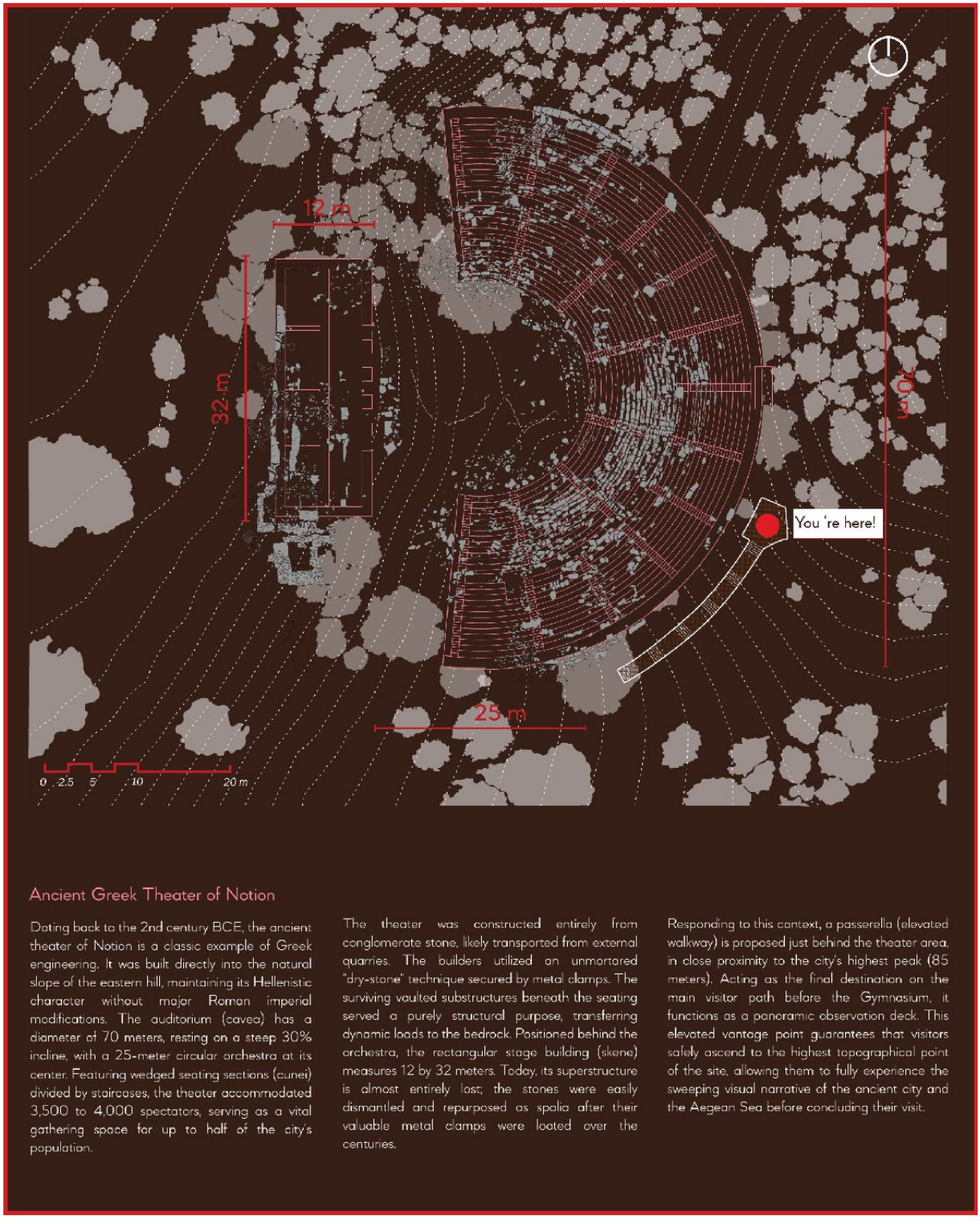


Figure 228. First Interpretive Panel on the Theater, graphics by author.



Ancient Greek Theater of Notion

Dating back to the 2nd century BCE, the ancient theater of Notion is a classic example of Greek engineering. It was built directly into the natural slope of the eastern hill, maintaining its Hellenistic character without major Roman imperial modifications. The auditorium (cavea) has a diameter of 70 meters, resting on a steep 30% incline, with a 25-meter circular orchestra at its center. Featuring wedged seating sections (cunei) divided by staircases, the theater accommodated 3,500 to 4,000 spectators, serving as a vital gathering space for up to half of the city's population.

The theater was constructed entirely from conglomerate stone, likely transported from external quarries. The builders utilized an unmortared "dry-stone" technique secured by metal clamps. The surviving vaulted substructures beneath the seating served a purely structural purpose, transferring dynamic loads to the bedrock. Positioned behind the orchestra, the rectangular stage building (skene) measures 12 by 32 meters. Today, its superstructure is almost entirely lost; the stones were easily dismantled and repurposed as spolia after their valuable metal clamps were looted over the centuries.

Responding to this context, a passerella (elevated walkway) is proposed just behind the theater area, in close proximity to the city's highest peak (85 meters). Acting as the final destination on the main visitor path before the Gymnasium, it functions as a panoramic observation deck. This elevated vantage point guarantees that visitors safely ascend to the highest topographical point of the site, allowing them to fully experience the sweeping visual narrative of the ancient city and the Aegean Sea before concluding their visit.

Figure 229. Second Interpretive Panel on the Theater, graphics by author.

08.

CONCLUSION

8.1 Conclusion

The thesis began from the condition of the ancient city, in which two thousand years of abandonment; the ruins and vegetation can no longer be separated. The ruin and the Mediterranean flora of the city have become a single living organism; therefore, the plants that have grown are at once an agent of decay and a carrier of the site's memory, the *patina del tempo* that records the passage of past centuries. Challenging the approach of clearing nature from the archaeological remains, the study has argued that this condition should be managed by proposing interventions only where nature genuinely endangers the ruins. This is the principle of *managed coexistence* that has guided the study from a broader scale down to the architectural scale of the theater.

Translating this principle into practice, the research relies on a comprehensive assessment protocol rather than a single analytical instrument. The vulnerability analysis distinguished the inherent weaknesses of the site (intrinsic factors) from the external impacts acting upon them (extrinsic factors), while linked together by a risk equation. The vegetation analysis applied Signorini's Hazard Index (*Indice di Pericolosità*) alongside the biomechanical assessments. This allowed evaluation of each plant species individually, rather than treating the vegetation as a green threat. Additionally, the surveys of stone pathologies defined by the alteration patterns, recorded the actual decay of the cavea.

Synthesizing these analyses led to the understanding of the thesis; the vegetation at Notion could not be considered uniformly harmful. While the site contains the high hazard plants that could cause aggressive deteriorations, the broader flora consolidates the unstable cavea topography, while its cover shields the porous conglomerate from more severe degradation. However, this protective role is not abstract. The vegetation analysis demonstrates that some species, even when classified as hazardous, still protect the

ruins in certain ways. Wild olive (Olea europaea), despite damaging the stone with its roots, fills cracks and consolidates the loose soil on the cavea slopes, preventing the erosion that removing the vegetation would actually cause. These examples show that a plant's relationship with a ruin is never simply harmful or helpful; it depends on the species and where it grows.

A complete cleaning or eradication of the vegetation would therefore not conserve the ruin but exchange one form of damage for another.
The design proposals are a direct response to these risk assessments. In order to mitigate the severe extrinsic hazards identified in the analysis due to the anthropogenic factors and uncontrolled access, the comprehensive visitor and hiking framework is proposed to redirect the anthropogenic pressures. The architectural interventions as Theater Passarella enhance the visitor orientation and the archaeological landscape experience. This approach efficiently transforms an unmanaged threat into a controlled, low-impact intervention within the landscape.

Ultimately, this study repositions Notion as a living archaeological heritage, one where vegetation is not a pathology to be cleared but a constitutive layer of the ruin's identity and its *value di ruderi* (ruin value). It presents Notion not only as a ruin to be cleaned but as a landscape to be assessed. Reinterpreting its memory is not reconstructing a lost city; it is to keep an open dialogue between ruin and flora, between history and nature, that two millenia of abandonment have inscribed along the ancient site, and ultimately allowing visitors to experience that dialogue rather than erasing it.

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8.3 Figures

- Figure 1. Diagram of the problem statement and the conceptual framework of the study. Diagram by the author.
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- Figure 103. The Byzantine tower at Notion. Source: Demangel and Laumonier (1923), fig. 6.

The Byzantine tower at Notion, constructed with spoliated blocks from the Temple of Athena, prior to its demolition by the French excavation team in 1921. Source: Robert Demangel and Alfred Laumonier, "Fouilles de Notion (1921)," Bulletin de correspondance hellénique 47 (1923), fig. 6.

- Figure 104. Large dolium exposed by illegal excavators north of the Agora. Source: Ratté (2022).

Large dolium (storage jar) exposed by illegal excavators north of the Agora at Notion, illustrating the extent of illicit excavation activity and the resulting damage to the archaeological deposits. Source: Christopher Ratté, "Notion Arkeolojik Yüzey Araştırması 2021" (unpublished report, Notion Archaeological Project, University of Michigan, 2022).

- Figure 105. Recent illicit excavation trench in the Gymnasium. Source: Ratté (2022).

Recent illicit excavation trench in the Gymnasium area at Notion, demonstrating the ongoing threat of looting to the archaeological integrity of the site. Source: Christopher Ratté, "Notion Arkeolojik Yüzey Araştırması 2021" (unpublished report, Notion Archaeological Project, University of Michigan, 2022).

- Figure 106. Map of illicit excavation locations at Notion. Map by author, based on Ratté, Rojas, and Commito (2015), figure 11.

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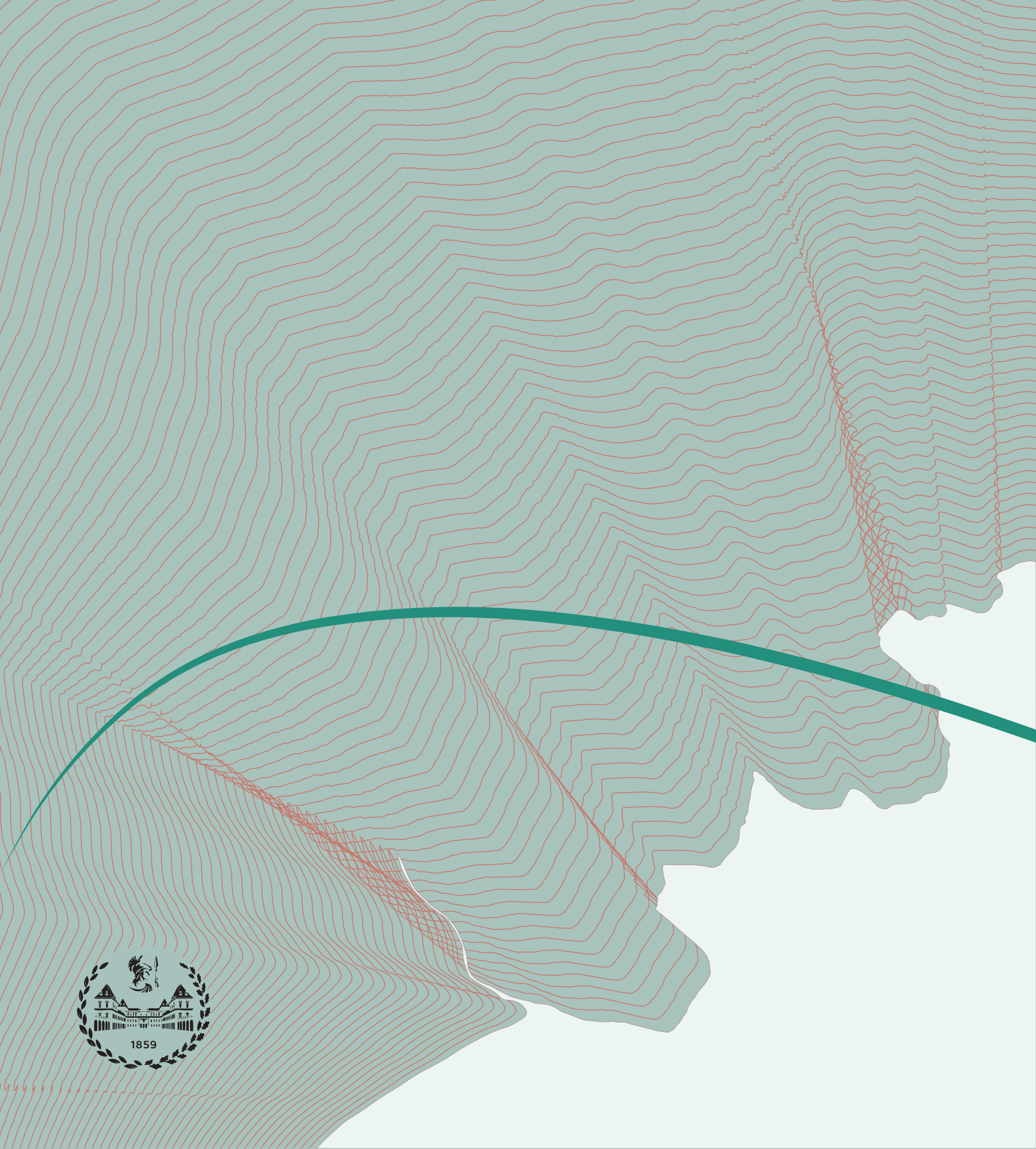
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