BEYOND THE CITY OF PERGAMON

A Landscape Archaeological Study of the Pergamon Micro-Region from the Hellenistic to the Roman Imperial Period

Dissertation

by

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We can learn about our future from our past
because, regardless of technology or the speed of innovation, people are still people.

Simon Sinek [@simonsinek] (April 22, 2016). Twitter
https://twitter.com/simonsinek/status/723572056735010816

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Abstract

This cumulative thesis is a landscape archaeological study with the aim of identifying and interpreting the interdependencies between the ancient city of Pergamon on the western coast of Asia Minor (present-day Türkiye), urban and rural settlements, and the landscape within its micro-region from the Hellenistic to the Roman Imperial period (3rd century BCE – 3rd century CE). To this end, a research approach based on the category of the micro-region as a spatial and conceptual framework, digital landscape-based analyses, and archaeological surveys was adopted. By means of three case studies on specific aspects of the micro-region and their synthesis, it is thus possible to significantly modify the previous understanding of rural space and its significance for the history of the city of Pergamon.

This thesis is able to demonstrate that the settlement structure of the Pergamon Micro-Region underwent a transformation during the period under study, while the city of Pergamon experienced a fundamental urban transformation and changes in its political and social framework. It shows that this transformation was an expression of the dynamically changing needs that emanated from the rulers, the city, and its inhabitants, and that it was promoted by the heterogeneous landscape and Pergamon's location within it. Thus, previous assumptions about a potential transformation of the rural settlement structure can be put on a much more solid data basis and completely re-evaluated, and the close interdependencies between Pergamon and its micro-region can be revealed.

This thesis provides an essential contribution to the ongoing project of the study of Pergamon and the micro-region in which it is embedded. Moreover, it vividly demonstrates how a strongly landscape-based and interdisciplinary approach can be used to arrive at meaningful interpretations that go beyond an individual city and the boundaries artificially drawn by purely geographical or historical-archaeological considerations.

With the consistent use of open-source software and the transparent presentation of all analyses, this thesis also guarantees connectivity for further discussions and research on Pergamon and should at the same time offer motivation to apply the approach presented here to the micro-regions of other ancient cities in Asia Minor and beyond in order to arrive at comparative studies and common answers and insights in the future.

Zusammenfassung

Bei der vorliegenden kumulativen Dissertation handelt es sich um eine landschaftsarchäologische Studie mit dem Ziel die Interdependenzen zwischen der antiken Stadt Pergamon an der kleinasiatischen Westküste (heutige Türkei), städtischen und ländlichen Siedlungen und der Landschaft innerhalb ihrer Mikroregion vom Hellenismus bis zur römischen Kaiserzeit (3. Jh. v. Chr. – 3. Jh. n. Chr.) zu identifizieren und zu interpretieren. Zu diesem Zweck wurde ein Forschungsansatz gewählt, der auf der Kategorie der Mikroregion als räumlichem und konzeptionellem Rahmen, digitalen landschaftsbasierten Analysen und archäologischen Surveys basiert. Anhand von drei Fallstudien zu spezifischen Aspekten der Mikroregion und deren Synthese kann somit das bisherige Verständnis des ländlichen Raumes und seiner Bedeutung für die Geschichte der Stadt Pergamon deutlich modifiziert werden.

Diese Dissertation kann nachweisen, dass die Siedlungsstruktur der Mikroregion Pergamon im Untersuchungszeitraum einer Transformation unterlag, während die Stadt Pergamon einen grundlegenden urbanen Wandel und Veränderungen der politischen und sozialen Rahmenbedingungen erlebte. Sie zeigt, dass diese Transformation ein Ausdruck der sich dynamisch verändernden Bedürfnisse war, die von den Herrschern und der Stadt und ihren Bewohnern ausging, und dass sie durch die heterogene Landschaft und die Lage Pergamons darin befördert wurde. Somit können nicht nur bisherige Annahmen zu einer potentiellen Transformation der ländlichen Siedlungsstruktur auf eine deutlich solidere Datengrundlage gestellt und völlig neu bewertet werden, sondern auch die engen Interdependenzen zwischen Pergamon und seiner Mikroregion aufgedeckt werden.

Diese Dissertation liefert damit einen wesentlichen Beitrag für das derzeit laufende Projekt zur Erforschung Pergamons und seiner Mikroregion, in das sie eingebettet ist. Darüber hinaus demonstriert sie anschaulich, wie man mit einem stark auf die Landschaft ausgerichteten und interdisziplinären Ansatz zu aussagekräftigen Interpretationen gelangen kann, die über eine individuelle Stadt und die durch rein geografische oder historisch-archäologische Überlegungen künstlich gezogen Grenzen hinaus gehen.

Mit der konsequenten Anwendung von open-source Software und der transparenten Darstellung aller Analysen garantiert die vorliegende Dissertation außerdem die Anschlussfähigkeit für weiterführende Diskussionen und Forschungen in Pergamon und soll gleichzeitig motivieren, den hier präsentierten Ansatz auf die Mikroregionen anderer antiker Städte in Kleinasien und darüber hinaus anzuwenden um so zukünftig zu vergleichenden Studien und übergreifenden Antworten und Erkenntnissen zu gelangen.

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1. Introduction

Ancient Pergamon was one of the largest and most important cities in Asia Minor. The city developed its influence from a hill on the northern edge of the Bakırçay Plain (ancient Kaikos Plain), about 25 km inland from the Aegean coast in present-day western Türkiye (Fig. 1.1). Pergamon attained its greatest degree of power and supra-regional importance in the Hellenistic period as a seat of the Attalid ruling dynasty and the center of the Pergamene Empire. In the Roman Imperial period, the city continued to exert great influence as a metropolis within the Roman province of Asia.

The occupation of what would become the city hill began in prehistoric times, and it had never been completely abandoned until the present day.[1] The settlement shifted over time to the foot of the former city hill, where the present-day town of Bergama is located. Thus, Pergamon remained the home of people for many generations and never fell into oblivion. The ancient heritage of the city has been preserved by, among others, ancient authors, early travelogues, and the architectural remains of ancient buildings visible above ground. Finally, the excavation of these remains, starting in 1878, marked the beginning of scientific research and a turning point for our current knowledge of ancient Pergamon.

In order to understand the history of Pergamon, however, it is essential to extend the research into the rural landscape, i.e., the Pergamon Micro-Region. It comprises the lower Bakırçay Plain and its estuary, the Kozak and Madra Dağı Mountains (ancient Pindasos), the Gölçük Mountains, the Yunt Dağı Mountains (ancient Aspordenon), the Kara Dağı Mountains (ancient Kane), as well as the coastline along those mountains (Fig. 1.1). The majority of the population lived in the countryside, where they probably produced most of the goods and exploited important resources. Yet, for a long time, the research interest in the rural area of Pergamon did not in any way reflect this. Parallel to the start of research and excavations in Pergamon at the end of the 19th and beginning of the 20th centuries, the geology and topography of the region were explored and numerous ancient sites were documented.[2] After this promising start, however, the focus turned almost exclusively to Pergamon and the extra-urban Asklepieion sanctuary.

With few exceptions, the Pergamon Micro-Region was not further included in the study of the city's history. In the last 16 years, the situation has changed. Archaeologists, historians, and geoscientists have once again become increasingly aware of the countryside of Pergamon and carried out interdisciplinary fieldwork. The documentation of ancient settlement traces, core drillings, and sediment analyses have yielded new insights into the settlement history and past human-environment interactions in the micro-region. Research outside the city, however, has mostly focused on individual *poleis* (e.g., Elaia, Atarneus, or Kane) rather than the landscape. A comprehensive investigation on a micro-regional scale has therefore remained a desideratum of research.

1 Pirson 2017, 49 with note 13.

2 Philippson 1902; Conze 1912.

As an important component of a current project investigating the 'Transformation of the Pergamon Micro-Region between the Hellenistic and the Roman Imperial Period (TransPergMikro),'[3] this thesis aims to address this gap and to broaden the view from place to landscape. The goals of this thesis are therefore

- the identification and interpretation of interdependencies between the city of Pergamon, other urban and rural settlements, and the landscape in the Pergamon Micro-Region,
- the evaluation of a possible transformation of the rural settlement structure during the phase from the Hellenistic to the Roman Imperial period (3rd century BCE – 3rd century CE), and
- the presentation of a comprehensive landscape archaeological study of an ancient micro-region through time, which allows interpretations that go beyond an individual city.

This involves not only the physical landscape, the natural barriers of mountains, and connections across seas and rivers but also the access to natural resources and the human perception of the landscape. The landscape archaeological approach emphasizes the landscape surrounding the ancient city as a factor influencing administrative-political, economic, and sociocultural processes. Although it is not considered as *the* determining factor, it is the one that has largely been disregarded in the past in the study of ancient Pergamon.

The landscape archaeological approach requires a conceptual framework that enables the interactions between humans and the natural environment outside the city of Pergamon to be addressed in all their contexts, going beyond the boundaries artificially set by merely geographical or historical-archaeological considerations. For this purpose, the category of micro-regions is employed in this thesis. Micro-regions are not defined by fixed (geographical) boundaries but are dynamic spaces of interaction between humans and the natural environment. Their extent can therefore vary depending on the level of interaction (e.g., economic, military, sociocultural) and the applied research approach with its theoretical framework.[4] Furthermore, micro-regions are subject to constant and dynamic changes. Regardless of their scale or speed, these transformative processes can only be identified and interpreted over a long-term study period, i.e., a *longue durée*.[5] Accordingly, the focus of this thesis is the phase from the Hellenistic to the Roman Imperial period. For this phase, an extensive urban transformation of the city of Pergamon has already been identified, which must have had an impact on the micro-region.[6] At the same time, previous research[7] provides initial evidence for a concurrent transformation of the settlement structure of the micro-region, which will be evaluated and reassessed in conjunction with the newly achieved results in the synthesis of this thesis.

To achieve the intended goals, this thesis applies digital spatial analyses from three major fields: visibility analyses, geomorphometric analyses, and the modeling of movement. These analyses address the

3 'Die Transformation der Mikroregion Pergamon zwischen Hellenismus und römischer Kaiserzeit (TransPergMikro)' (2019–today), F. Pirson, B. Schütt, T. Schulz-Brize, project number 419349690, German Research Foundation (DFG).

4 Pirson 2020, 158. For a detailed account of the category of micro-regions, see chapter 2.2.

5 Schuler 2016, 306.

6 Pirson 2017.

7 Zimmermann et al. 2015; Pirson 2017.

characteristics of the earth's surface and past human behavior on an inter-site level, linking the spatial components of archaeological sites to each other and to elements of the natural environment, e.g., relief, sea, or rivers.

These analyses are complemented by archaeological surveys in the Pergamon Micro-Region conducted with conceptual contributions from the author, with his participation, and under his supervision (field directorship).[8] These surveys have significantly expanded the archaeological data basis and were used to verify the results and interpretations of the analyses, which enhanced the reliability of the case studies. So far, the survey results, which are an essential complement to the case studies and synthesis, have been published exclusively in annual reports and are therefore included in the appendices A.1–A.4.

Through the detailed presentation of the theoretical framework and approach, the consistent use of open-source software, and the transparent documentation of the analyses, this study can furthermore serve as a basis and motivation for future research on other ancient micro-regions.

This cumulative thesis mainly bases on three case studies in which specific aspects of the Pergamon Micro-Region are examined in detail before their results are integrated in a synthesis. They have been published in three reviewed articles[9]:

(1) B. Ludwig, Reconstructing the Ancient Route Network in Pergamon's Surroundings, Land 9 (8), 241, 2020. (own contribution: 100 %)

Routes are not only a symbol of the close connection between city and countryside but also formed the infrastructural framework of the Pergamon Micro-Region in antiquity. They were used to access vital resources, for the trade and transport of agricultural goods, and they also facilitated communication and military movements. Chapter 5.1 therefore aims to reconstruct the ancient route network in the surroundings of Pergamon by combining historical and archaeological sources with modern computer-aided least-cost path analyses, while also considering landscape changes that have occurred since antiquity. The article reveals a well-developed route network shaped by the natural environment and connecting Pergamon with rural settlements. It thus makes a significant contribution to the evaluation of the settlement structure over time and from a landscape archaeological perspective.

(2) B. Ludwig, Pergamon's Access to the Sea. Analysis of its Landing Sites with a Focus on Connectivity and Visibility, in: U. Mania (ed.), Hafen, Stadt, Mikroregion. Beiträge der Arbeitsgruppe 5 ‚Hafenorte' des Forschungsclusters 6 ‚Connecting Cultures' und einer Tagung am 26. und 27. Mai 2017 an der Abteilung Istanbul des DAI, Menschen – Kulturen – Traditionen 18 (Wiesbaden 2022) 91–108. (own contribution: 100 %)

Due to Pergamon's location, about 25 km inland, access to the sea played a vital and decisive role in the development of the city and its micro-region in antiquity. This access could be ensured via landing sites along the coast, which served as destinations and hubs for all maritime activities, including economic and

8 The archaeological surveys were carried out in the context of the Pergamon Excavation Project of the German Archaeological Institute (DAI), under the direction of F. Pirson and with the permission of the Ministry of Culture and Tourism of the Republic of Türkiye.

9 Chapter 5.1 underwent a single-blind review and chapter 5.3 a double-blind review. Chapter 5.2 underwent a review procedure by the editors.

military aspects in particular. In chapter 5.2, different types of landing site (harbors, ports, opportunistic ports, and *villae maritimae*) are therefore first discussed, showing both their functional diversity and their structural hierarchy. Taking into account the distinctive topography along the coast, characterized by the Kara Dağı Mountains and its steep cliffs and small bays, visibility and least-cost path analyses were then carried out in order to analyze the interdependencies between these coastal places, Pergamon, and the micro-region. The article also shows a transformation of the coastal settlement structure in the phase from the Hellenistic to the Roman Imperial period.

(3) B. Ludwig – D. Knitter – Ch. Williamson, A Landscape of Surveillance. Investigating Hellenistic Fortifications and Potential Networks of Interaction in the Pergamon Micro-Region. Archäologischer Anzeiger 2022/2 (in press). (own contribution: 70 %)

The urban development and success of Pergamon was highly dependent on unrestricted and permanent access to its micro-region, which provided essential resources and important transportation and communication routes. These had to be monitored and controlled by means of fortified places at strategic locations in the landscape. The investigation of these fortified places in chapter 5.3 follows a landscape approach with a novel combination of visibility analyses, site location analyses, and the modeling of movement. Based on the results, it was possible to assess the degree of surveillance and control of the micro-region and the extent to which a network of surveillance based on visibility was established, particularly during the turbulent Hellenistic period under Attalid rule. Moreover, it turned out that this network of surveillance became less important during the transition to the Roman Imperial period. The article thus highlights the close interdependencies between the city of Pergamon and neighboring rural settlements. It also represents an important element for the evaluation of a possible transformation of the settlement structure within the micro-region.

To provide a general and coherent framework, the three main publications (chapters 5.1–5.3) are framed by an overview of the current state of the art (chapter 2), a detailed description of the study area (chapter 3), and the methodological framework of this thesis (chapter 4). Finally, in chapter 6, the results of the archaeological surveys and case studies are integrated in a synthesis, sketching a new picture of the Pergamon Micro-Region from the Hellenistic to the Roman Imperial period that goes beyond the city of Pergamon and individual rural settlements.

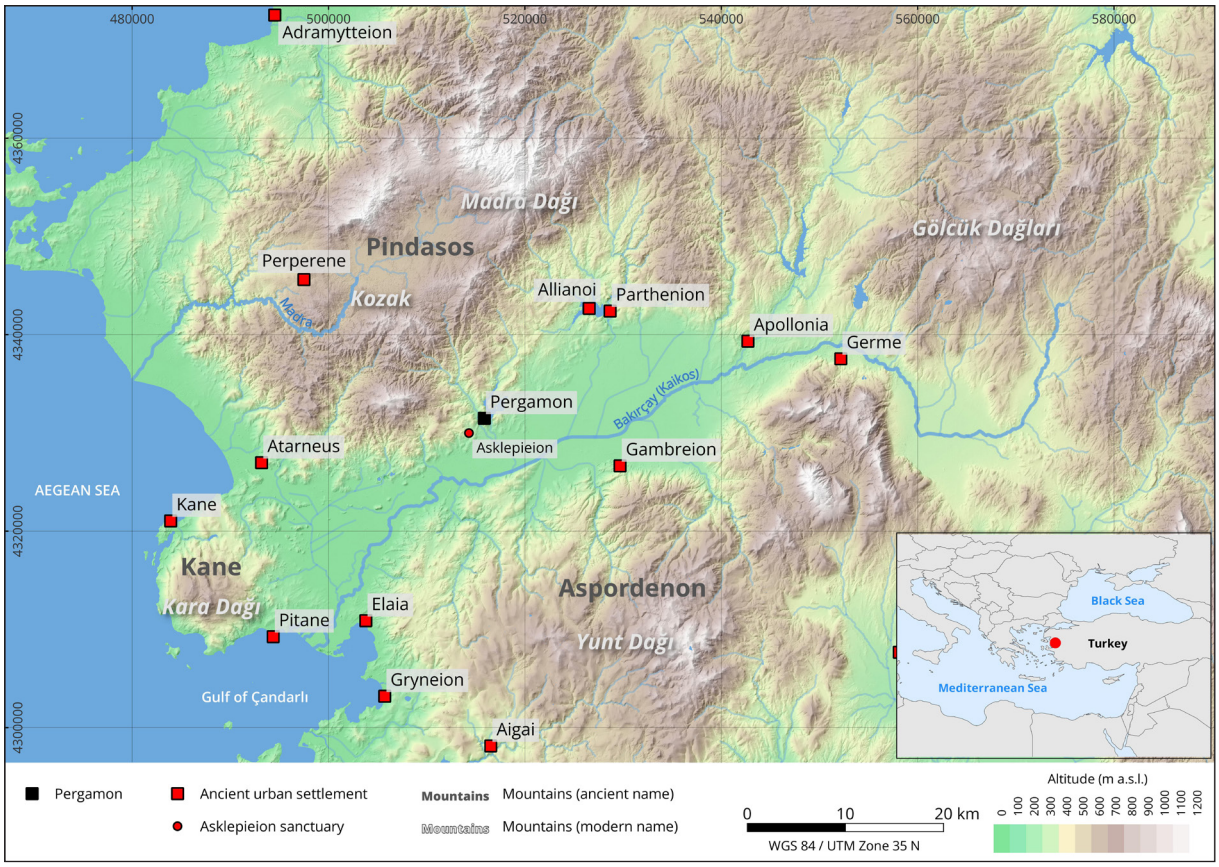

Fig. 1.1 The Pergamon Micro-Region in the context of the Eastern Mediterranean.

2. State of the Art

2.1 Landscape and Landscape Archaeology

A brief introduction to the terms landscape and landscape archaeology is necessary for an understanding of the landscape archaeological approach. Any attempt at an extended discussion of the concepts of landscape or a detailed account of the development of landscape archaeology as a discipline, however, would exceed the limits of this thesis.[10]

There is no standard definition for the term landscape. Landscape refers to a variety of aspects (e.g., geographic, social, economic, political, or territorial) and therefore has many, sometimes diffuse, meanings and definitions that are used differently depending on the discipline. The characteristics and elements of a landscape that are relevant for this thesis, i.e., the interaction between humans and the natural environment and the distribution of places across space and time, can be illustrated by means of the 'Landscape Wheel,' which was introduced in the context of Landscape Character Assessment (LCA) in England (Fig. 2.1).[11] Accordingly, a landscape consists of a) scientifically ascertainable components of the natural environment (e.g., landform, hydrology, soil, or land cover), b) subjective human perceptions manifested in preferences, associations, and memories, and c) socially and culturally shaped elements (e.g., land use, settlements, or land ownership). The Landscape Wheel is driven by time, corresponding to the interrelationship established between humans and places. When set in motion, the landscape components interact with each other continuously and generate effects of different intensities on the landscape, leading to distinctive characteristics. Their combination as well as their interrelationships ultimately make a landscape unique and distinguish it from others.

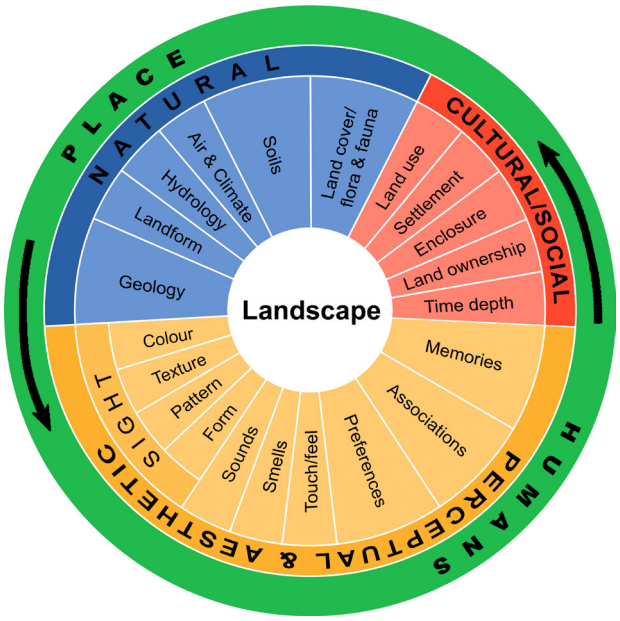

Fig. 2.1 Landscape Wheel (modified after Tudor 2014).

10 For a detailed theoretical discussion, in-depth accounts of 'landscape archaeology' as a concept, its development as a discipline in different regions, and for a summary overview, see Gramsch 2003; David – Thomas 2008a; Kluiving – Guttmann-Bond 2012b; Doneus 2013; Teichmann 2017; Knitter et al. 2018.

11 Tudor 2014.

Landscape can thus be understood as the result of the interplay of components that shape or change space. Following individual questions, single components can be investigated by means of digital spatial analyses. In the context of this thesis, for example, the natural environment is represented through landform analysis and human perception through visibility analysis. Settlement as a cultural and social component of the landscape is also examined in the form of sites, routes, and shoreline development (harbors and landing sites). The interactions between humans and the natural environment or the interdependencies between landscape and the distribution, function, and quality of ancient settlements and infrastructure, however, can only be identified and interpreted through the synthesis of the individual aspects. If possible, this should cover all the main components of a landscape (natural, cultural/social, perceptual), similar to this thesis.

Accordingly, this understanding of landscape requires interdisciplinary collaboration.[12] The humanities and natural sciences, which usually study single landscape components with their own methods, have to work together.[13] Landscape archaeological research thus involves different research traditions offering different approaches, questions, and methods. Due to these different preconditions, the interdisciplinarity of landscape archaeology is sometimes seen as a challenge.[14] On the other hand, the diversity of concepts and their discussion also leads to debate and expands mutual understanding.[15] The value of landscape archaeological projects or studies lies in the interdisciplinary collaboration, which creates a scientific added value and knowledge gain that a single discipline alone would not achieve.

This collaboration, however, leads to the difficulty of defining landscape archaeology. Due to the interdisciplinarity and the widespread and frequent use of the term, its definition has been and continues to be controversial.[16] Numerous definitions exist with different research directions and emphases, depending on the research to be carried out.[17] In retrospect, the concept of landscape archaeology has also changed, and today an enormous range of topics is subsumed under this term. Their commonality, however, is reflected in their focus on the reciprocal interactions between humans and the natural environment or how the landscape influenced humans in their behavior and how human behavior in turn shaped the landscape.

For example, Bruno David and Julian Thomas understand landscape archaeology as "an archaeology of how people visualized the world, how they engaged with one another across space, how they chose to manipulate their surroundings or how they were subliminally affected to do things by way of their located circumstances. It concerns the intentional and the unintentional, the physical and the spiritual, human agency and the subliminal."[18] In David and Thomas's understanding, human-environment interactions take place across space. Landscape archaeological research goes beyond the individual site.

12 For an overview of the variety of disciplines that may be involved in the study of landscape, see Förster et al. 2013.

13 Knitter et al. 2018, 179.

14 Barker – Mattingly 2016, ix; Meier 2012.

15 Darvill 2008, 68–69.

16 Hu 2012, 80.

17 E.g., Gramsch 2003; Wilkinson 2003, 3–4; David – Thomas 2008b, 38; Haupt 2012, 13–15; Hu 2012, 80; Kluiving – Guttmann-Bond 2012a, 15; Doneus 2013, 39; Denham 2017, 465–466; Kennedy 2021, 31.

18 David – Thomas 2008b, 38.

It moves from single site analysis to a spatial and diachronic correlation of sites with each other and with the landscape. In their definition of landscape archaeology, however, another essential aspect remains unmentioned: the time frame.

Tony Wilkinson prioritizes this aspect when he argues that landscape archaeology is "concerned with the analysis of the cultural landscape through time. This entails the recording and dating of cultural factors that remain as well as their interpretation in terms of social, economic, and environmental factors."[19] The aspect of the temporal frame is of great relevance for landscape archaeological research because human-environment interactions generate changes that can only be recognized and assessed over a longer period of time, i.e., through a diachronic approach. Accordingly, the focus of a landscape archaeological study may be on a specific period, but the processes and changes analyzed should be considered in the context of a *longue durée*.

This thesis therefore considers landscape archaeology as the study of how past landscapes structured, and have in turn been structured by, past human behavior across space. The prefix 'landscape' indicates the natural, physical environment and its analysis, primarily through geoscientific methods. In accordance with the understanding of landscape described above (Fig. 2.1), however, the component of the natural environment is in constant interplay with the component of human behavior (perceptual and sociocultural) that shapes or changes space. This is where the term 'archaeology' becomes relevant. It refers to the discipline of the humanities and to the interest in exploring the cultural development of humans in the context of the surrounding landscape. Accordingly, landscape archaeology is concerned with the recursive and mutually determining nature of human-environment interactions in a diachronic perspective.[20]

Landscape archaeology thus has some overlap with other fields, including geoarchaeology, but the terms should not be used interchangeably. Landscape archaeology and geoarchaeology differ in their methods, in their understanding of the term landscape and the role of humans in it, and in the general category of space they address. Geoarchaeology primarily applies geoscientific methods analyzing geo-bio-archives, which may be natural (e.g., alluvial fans, rivers, or lakes) or anthropogenic (e.g., terraces, harbors, or settlement mounds).[21] By using these archives, geoarchaeology reconstructs human-environment interactions in an archaeological context. In contrast to landscape archaeology, humans are thereby included in the study but are not considered as part of the landscape; they are only considered as one of many potential influencing factors within the studied system.[22] Furthermore, the potential effects of human-environment interactions remain limited to geometrical and physical space and are thus quantifiable using scientific methods. Landscape archaeology, in contrast, deals with all facets of space, including cognitive space (e.g., social, religious, and political concepts).[23]

Compared to geoarchaeology, landscape archaeology can draw on a broad spectrum of methods from the humanities and natural sciences. In this respect, the increasing availability of remote sensing data in

19 Wilkinson 2003, 3–4; with reference to Metheny 1996.

20 Adapted according to Denham 2017, 465–466.

21 Engel – Brückner 2014; Hill – Rapp 2020; Brückner et al. 2022.

22 Nykamp 2017, 4–8; Kennedy 2021, 31–32.

23 Doneus 2013, 45–46.

recent years, both space-based and ground-based, has facilitated a great leap forward. This highlights the flexibility of landscape archaeology and its applicability at different scales.[24] Great potential also lies in the development of new digital technologies that allow past landscapes to be modeled, from quantifiable features to cultural constructs.

These are the approaches taken in this thesis. Based on the theoretical category of the micro-region, it combines traditional ways of working and fieldwork with state-of-the-art remote sensing data and digital spatial analysis to analyze all facets of the studied landscape. This approach offers great potential for the study of a historical, transforming micro-region and in terms of environmental change and the resilience and adaptive capacities of its inhabitants.

24 Fleming 2012.

2.2 City, Countryside, and Micro-Region – A Theoretical Framework

While the city of Pergamon is fairly well-researched by now, this thesis is dedicated to its relatively little-known micro-region. We owe our knowledge to date to the work of various disciplines that have researched the Pergamon Micro-Region over a long period and at different stages.[25] This has resulted in different research approaches and perspectives, each with its own concepts, terminologies, and understandings of the relationships between city and countryside or between humans and the natural environment. In order to understand the case studies and the synthesis of this thesis, it is thus crucial to discuss the spatial categories, concepts, and basic terminologies applied in the research of the Pergamon Micro-Region and other ancient landscapes in western Asia Minor so far. Following this, the category of micro-regions is outlined and related to Pergamon.

To understand the history of an ancient city, one must look at its broader countryside.[26] The thesis therefore goes beyond the city with its monumental buildings and turns its attention to the Pergamon Micro-Region. The shift of attention away from the city and toward the countryside was recognized as early as the 1990s as being "archaeology's most important contribution to the study of the ancient city."[27] It reflects the value of studying rural landscapes in order to understand the developments and history of urban settlements and cities. Since then, the increasing number of archaeological surveys and geoscientific investigations has led to a continuous intensification of the study of ancient landscapes. In western Asia Minor, historical-geographical research on the ancient *polis* of Kyaneai and its territory in Lycia set new standards in the 1990s. On the basis of historical-geographical research and archaeological fieldwork, sites in a region were recorded in order to investigate its history, including political changes and their effects on settlement and landscape.[28] For a comprehensive and especially interdisciplinary study of an ancient landscape, however, the research in the surroundings of Sagalassos since the 1990s has been groundbreaking for Classical and Roman archaeology beyond Asia Minor.[29] There, past human-environment interactions have been studied from the beginning using geo- and bioarchaeological and archaeometric methods, among others.[30] This development of interdisciplinary research has been accompanied and promoted by the emergence of digital technologies, most notably Geographical Information Systems (GIS). The Aphrodisias Regional Survey, for example, conducted from 2005 to 2009 to study the relationships between human habitation and the natural environment around Aphrodisias, published its entire GIS data online as early as 2012, in parallel with the publication of the results.[31] Today, an extensive toolbox of remote sensing techniques and digital methods for

25 See chapter 2.3.

26 Rich – Wallace-Hadrill 1991; Lang 1999; Zimmermann 2015a; Zuiderhoek 2017.

27 Wallace-Hadrill 1991, x. On the need to focus on all aspects of the surrounding countryside of Roman cities and to make full use of all available methods, see also Johnson 1989, 161.

28 See, e.g., Zimmermann 1992; Kolb 1993; Kolb – Thomsen 2004; Kolb 2008.

29 Poblome 2013b, 23. See also Waelkens 1997 and several contributions in Poblome 2013a.

30 See, e.g., Vanhaverbeke – Waelkens 2003; Degryse – Waelkens 2008.

31 Ratté – Staebler 2012; University of Michigan Library 2012.

studying the relationships between ancient cities, settlements, and landscapes is available and continues to steadily grow.[32]

In Pergamon, as early as the beginning of the excavations in the late 19th and early 20th centuries, it was concluded that at least the immediate surroundings of the city had to be included in the investigations.[33] In 1886, Walther von Diest was commissioned by the Royal Academy of Sciences in Berlin to prepare a topographic map as "the outermost framework for the results of the excavations in Pergamon."[34] The area that was called the "Pergamene landscape" or "surrounding landscape" included the entire Bakırçay Plain and the adjacent mountains, without being geographically defined more precisely.[35] In the end, his map depicted the Kozak and parts of the Madra Dağı Mountains in the north, the entire Bakırçay Plain and the Kara Dağı Mountains on the Kane Peninsula, and the entire Yunt Dağı Mountains as far south as the Gediz Plain (ancient Hermos). On the basis of a map version later refined by Otto Berlet, the relationships between Pergamon and the countryside were then depicted for the first time.[36]

The example of Atarneus, an ancient city in the west of the Pergamon Micro-Region, illustrates very well that the development of individual sites should not be considered in isolation but can only be understood in a (micro) regional context.[37] While there is a consensus that the site was abandoned in the late Hellenistic period, the possible causes for this, for example environmental changes or political-administrative transformations, have so far only been sought and found outside the city.[38] Thus, a separation of city and countryside in the study of ancient cities is not very useful. Rather, city and countryside must be understood and analyzed as a complementary system.[39] Symbolic of this complementary system and the close connection between city, countryside, and rural settlements are the roads and paths that link everything together through a widely dispersed physical network, as studied in chapter 5.1.

Geoscientific Perspective

In order to study the relationships between cities or rural settlements based on distances, their size, or distribution in a region, concepts and models have been developed in geographical research. Johann Heinrich von Thünen's 19th-century model of the 'isolated state,' for example, refers to the supply of agricultural goods to a central market.[40] Around this market, circular agricultural zones are arranged in the most economical way, taking into account the distance to the market, i.e., the transport costs and

32 See chapter 4.3; Gillings et al. 2020; Siart et al. 2018 in general and for some of the relatively few case studies in Asia Minor, e.g., Janssen et al. 2017 (modeling wood consumption); Günther et al. 2021 (agent-based modeling); Knitter – Ludwig 2021 (open science and reproducible research); Laabs – Knitter 2021 (modeling agricultural production).

33 Schuchhardt 1887, 1207; Conze 1912, 65 (C. Schuchhardt). A similar approach was taken in Miletus: Wiegand 1929.

34 Diest 1889, 1.

35 Schuchhardt 1887; Diest 1889; Conze – Schuchhardt 1899; Conze 1912, 61–143 (C. Schuchhardt).

36 Conze 1912, 35–42 (O. Berlet), 61–143 (C. Schuchhardt). Similar maps were also created for the surroundings of other ancient cities in Asia Minor, such as Miletus or Ephesus: Wilski 1906; Schindler 1906.

37 Schuler 2016, 313–314.

38 Schneider et al. 2013; Schneider et al. 2014; Zimmermann et al. 2015.

39 Lang 1999.

40 Thünen 2017.

the relative speed with which the products spoil. In these zones, settlements cluster according to their agricultural specialization.[41] Other models attempt to discover and explain the hierarchy of settlements and their regular distribution. The 'central place theory' assumes a strong hierarchical division of space with a tendency toward centralization. Settlements produce different types of goods and services and provide them at specific scales. Depending on the quantity of goods and services, a settlement hierarchy with central places of different rank and different catchment areas emerges.[42] In 'the rank-size rule model,' on the other hand, the decisive variable is the number of inhabitants. The model assumes a regular correlation between the number of inhabitants of a place and its ranking in the settlement system.[43] There are a few large, many medium-sized, and a large number of small places. In relation to the largest city, the smaller places have fewer inhabitants according to their rank. The calculation of the rank-size ratio gives an indication of the settlement structure and population distribution within a region.

For the study of the Pergamon Micro-Region, only the 'central place theory,' complemented by the 'central-flow theory,'[44] has so far been applied. The study proposes a sudden increase of centrality to a high level for Pergamon at the beginning of the Hellenistic period, which remains stable during the Roman Imperial period and decreases steadily afterwards.[45]

Catchment analysis, which was devised by Claudio Vita-Finzi and Eric Higgs[46], was most recently adapted for a study on the food supply of Pergamon from the surrounding countryside. It examines the relationships between individual sites and the natural resources lying within their economic range. To investigate the degree of local self-sufficiency and to calculate a carrying capacity index, different models of the complementary regions (catchments) of Pergamon were used: the *chora* of Pergamon during the Roman Imperial period, a 16-hour walking territory, and the catchments of the Bakırçay and Madra Rivers (Fig. 2.2).[47]

The geoscientific perspective on the area is also reflected in other studies by defining the study areas on the basis of river catchments. Both for the study on the geology of Pergamon's surrounding area and for the study on the geomorphological characteristics of the region, the river catchments of the Bakırçay and Madra Rivers were defined as the study area in each case, with minor modifications. For the geological study, the area is given as about 6,000 km² and for the geomorphological study as 4,124 km².[48]

Ancient Historical Perspective

From an ancient historical perspective, the relationship between city and countryside can be encountered on a linguistic level. Ancient historians already encompassed both city and countryside in the Greek word *polis*. It denotes the city-state, which was centered on a city, but also encompasses the countryside,

41 Zuiderhoek 2017, 50–51; Doneus 2013, 284–285 also for the application in (landscape) archaeology.

42 Bernbeck 1997, 169–174; Christaller 2006; Knitter et al. 2013 with reference to Pergamon; Knitter 2014; Nakoinz 2019.

43 Bernbeck 1997, 175–179; Lang 1999, 10–15; Doneus 2013, 291; Zuiderhoek 2017, 52–53.

44 Taylor et al. 2010.

45 Knitter et al. 2013.

46 Vita-Finzi – Higgs 1970.

47 Laabs – Knitter 2021.

48 Philippson 1902; Yang et al. 2021.

including smaller towns and villages.[49] Since the urban core (*asty* or *urbs*) and the surrounding territory (*chora* or *ager/territory*) of ancient cities were understood as a single administrative and sociopolitical unit, there was no distinction between city and surrounding countryside.[50] Inhabitants of the *polis* could live in both urban and rural areas.[51] *Chora* and *polis* have consistently been the subject of research in Asia Minor since the 1990s, especially from a historical perspective.[52]

However, very little is still known about the *chora* of Pergamon, especially its extent and boundaries. For the *polis* Pergamon in the 4th century BCE, it is assumed that the *chora* just reached the Bakırçay River (ancient Kaikos) in the south. The extension to the north into the Kozak Mountains, possibly between 5 and 10 km, can still barely be reconstructed, and to the west and east it was bordered by Halisarna (Eğrigöl Tepe) and Parthenion, which did not belong to the *chora* of Pergamon (Fig. 2.2).[53] While this extension is also assumed for Attalid times, the assumed *chora* of Pergamon in the Roman Imperial

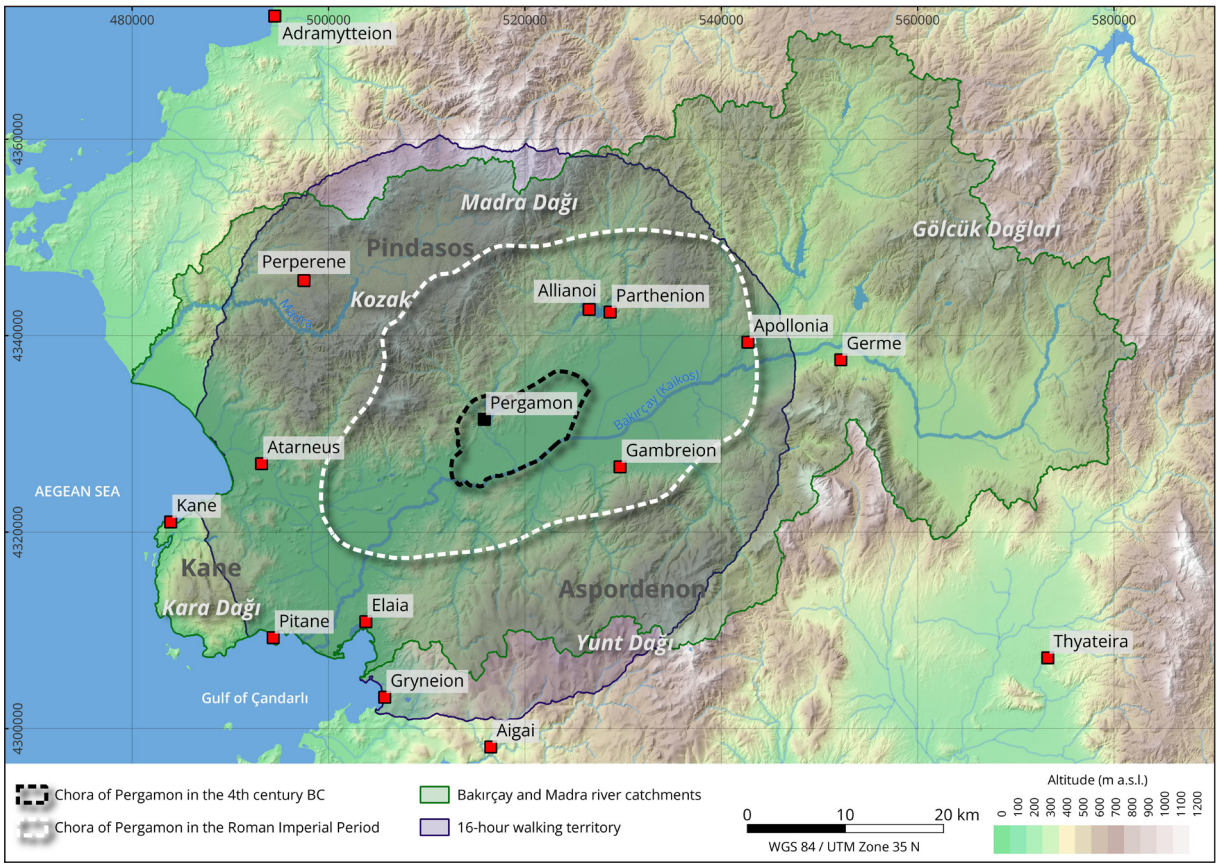

Fig. 2.2 The Pergamon Micro-Region with borders of a) reconstructed *chora* in the pre-Attalid period, b) reconstructed *chora* in the Roman Imperial period, c) catchments of the Madra and Bakırçay Rivers, d) 16-hour walking territory (a) and b) after Sommerey 2008, c) after Yang et al. 2021, d) after Laabs – Knitter 2021).

49 Hansen 2006; Hansen 2007.

50 Zuiderhoek 2017, 37.

51 For a discussion of the number of inhabitants of Pergamon in the 2nd–3rd century CE, see chapter 3.6.

52 See, e.g., Zimmermann 1992; Schuler 1998; Kolb – Müller-Luckner 2004; Matthaei – Zimmermann 2015; Hoffmann 2022.

53 See Sommerey 2008, 136–142 with Fig. 2.

period covers almost the entire lower Bakırçay Plain and foothills of the surrounding mountains.[54] The *chora* of Pergamon has most recently been the subject of an ancient historical survey project on the rural settlement structure of Pergamon, although the actual research has extended far beyond the boundaries of the *chora* in the west to include places such as Atarneus (Fig. 2.2).[55]

Territories and Regions

The increasing integration of the surrounding countryside into the study of ancient cities, especially with the growing number of archaeological and geo-archaeological surveys, the increasing accessibility to remote sensing technologies, both space-based and ground-based, and the developments of Geographical Information Systems in recent decades have increasingly brought the spatial categories of territories and regions into focus. The term territory is used differently by numerous disciplines, such as geography, sociology, anthropology, or biology, in order to "denote a specific space or spaces to which individuals or groups of animals and humans are attached on a relatively exclusive and permanent basis."[56] Even within individual disciplines, different approaches to the concept of territory are used, based on individual research questions. A precise definition valid for all contexts is therefore unlikely to be found, and the author does not propose his own definition here.[57] In the context of Pergamon as a Hellenistic residential city, for example, territory was recently defined as "the legally undefined area around the royal seat, on which the military and economic viability was dependent." (Author's translation)[58] The territory thus had to ensure control of the main transportation routes as well as access to vital resources.

Similar to the term territory, the term region is used in many ways both within and across disciplines. In general, a region describes a geographic spatial unit that can, for example, be administratively territorial through borders and boundaries, be delimited by economic forms with certain functions, or have a symbolic function.[59] In the context of this thesis and a landscape archaeological approach, the concept of region does not replace *polis* or *chora* but includes them.[60] Furthermore, in addition to these political-administrative boundaries, it also includes topographical conditions and linguistic, cultural, and social aspects.[61] At the same time, however, this differentiation creates a high degree of complexity. One example is the economic hinterland of an ancient city, which does not necessarily have to coincide with the political-administrative territory, the *chora*.[62] The demand for food of a large city like Pergamon, for example, could only be met through a region that extended far beyond the borders of the *chora* and

54 See Sommerey 2008, 142–150 with Fig. 3.

55 See note 111 and Zimmermann et al. 2015.

56 Zedeño 2008, 210.

57 For an overview on territory and territoriality in the context of landscape archaeological research, see Zedeño 2008.

58 Pirson 2008a, 29. Later, however, terms such as "inneres Herrschaftsgebiet" (inner dominion; Pirson 2012a, 219) and "Kerngebiet des Attalidenreiches" (core area of the Attalid kingdom; Pirson et al. 2015, 39-40) were used, which better correspond to the informal and administratively unspecified character.

59 Minshull 1967; Schuler 2016; Jones 2017 with further reading.

60 Schuler 2016, 311.

61 Elton – Reger 2007, 11–16.

62 Zuiderhoek 2017, 49.

included other cities and villages.[63] Likewise, social regions in the countryside of an ancient city can differ from political-administrative or economic regions. In the Pergamon Micro-Region, such social regions have most recently been studied using the category of 'visual regions,' i.e., areas that are included within a single frame of viewing.[64] The lower Bakırçay Plain, bounded by the mountains, forms a 'visual region' where the placement of natural sanctuaries and tumuli or the linking of myths and landmarks created social regions based on shared notions of topography, religion, myth, history, and ideology.[65] These studies build on previous research on the visual linkage of the Hellenistic residential city with its surrounding countryside through the positioning of extra-urban sanctuaries and the creation of visual axes.[66] In addition, the role of routes and the positioning of rural fortifications and funerary monuments as a spatial strategy for unlocking and symbolically occupying the territory of Pergamon has also been studied previously.[67]

Micro-Regions

A characteristic feature of all regions is their conceptualization at many different scales. Their extent and scale can vary from continental regions to local regions depending on specific questions and the theoretical perspective of the research approach.[68] An example of a continental region is Fernand Braudel's seminal study of the history of the 16th-century Mediterranean. He understands the Mediterranean as a unified space shaped by human relationships across space and time (connectivity).[69] Peregrine Horden and Nicholas Purcell follow on from this and likewise understand the Mediterranean as a unified space. Their approach, however, emphasizes local regions or micro-regions. Accordingly, the ancient Mediterranean is a widely ramified network of 'micro-ecologies' that are interdependent and have their own distinctive natural characteristics.[70] The constituent factors of these micro-regions are the natural environment and the human activities that establish the connections between the regions.

Although the importance of cities and settlements for the respective regions was barely emphasized by P. Horden and N. Purcell,[71] the interplay between cities and regions around the Mediterranean has been highlighted by several other studies. Using the example of a conurbation in Roman North Africa, Paul Scheding was most recently able to convincingly demonstrate that the regionally specific characteristics of a micro-region in turn shape individual cityscapes.[72] For Hellenistic and Roman Asia Minor, Christof Schuler was able to show, on the basis of written sources, that regionally different rural settlement patterns with local characteristics developed from the combination of cultural and topographical

63 Kobes 1999, 96–98; Laabs – Knitter 2021.

64 Chapter 5.3; Williamson 2012, 55–61.

65 Williamson 2016; Pirson – Ludwig (in press).

66 Wulf 1999, 41–44.

67 Pirson 2008a; Pirson 2012a.

68 Kantner 2008, 41–42.

69 Braudel 1972.

70 Horden – Purcell 2000. For critical reviews see, among others, Fentress – Fentress 2001; Nixon 2002; Molho 2002. For a response to critics, see Horden – Purcell 2005.

71 See, e.g., Fentress – Fentress 2001, 212; Harris 2005, 29–34.

72 Scheding 2019.

features.[73] Martin Zimmermann furthermore observed that ancient cities in Asia Minor could develop very differently within a few kilometers and that their success was inextricably linked to specific local or micro-regional conditions. Based on these observations and following P. Horden and N. Purcell's 'micro-ecologies,' he refined the spatial category of micro-regions to focus on the study of the diversity of ancient cities and micro-regions.[74] Accordingly, micro-regions consist of both the natural environment and the space that is integrated into the inhabitants' economic and political activities. It follows that micro-regions extend beyond the surrounding territory of a city and are not congruent with political, administrative, or topographical boundaries or landmarks.[75] Their extent is rather dependent on the actions and perceptions of humans within the landscape of the region.

For C. Schuler, the interactions between human activity and geography are the central characteristics of a region. He concludes that (micro) regions do not have fixed sizes but are subject to dynamic changes. Thus, he emphasizes time as an important element of a micro-region. Continuous interactions lead to transformation processes that can only be identified and analyzed over a longer period of time – the *longue durée*.[76]

Following the described approaches, Felix Pirson understands micro-regions as complex, tightly interconnected, and dynamic spaces of interaction between humans and the natural environment whose extent can change over time or depending on the selected level of analysis (e.g., political-administrative and military, cultural and social, economic, symbolic-religious).[77] On the one hand, he emphasizes the mutual interactions between humans and the natural environment and, on the other, the differentiation of the levels of analysis. Accordingly, the economic level of a micro-region, which includes resource exploitation or trade contacts, may have a different spatial extent than the military and political-administrative level, which includes securing and the manifestation of territorial power. He furthermore considers the epistemological meaning and function of the category 'micro-region' to be important.[78]

This understanding of the category of the micro-region is adapted in this thesis to examine the Pergamon Micro-Region. This thesis thus goes beyond the city-focused research of *chora* and *polis* or city and countryside to focus on the micro-region as a complex system of past human-environment interactions that allows us to examine their causes and effects across time and space.

The prefix 'micro,' however, implies that the micro-region is not an isolated island but rather part of a larger entity.[79] Let us recall the issue of scaling from continental to local regions described above. Accordingly, a large region consists of multiple micro-regions that may overlap and be intertwined. Depending on their development, characteristics, extent, and connectivity, rankings and hierarchies can emerge between micro-regions.

73 Schuler 1998.

74 Zimmermann 2015a.

75 Zimmermann 2015a, 404–405.

76 Schuler 2016, 306.

77 Pirson 2017, 92; Pirson 2020, 158.

78 Pirson 2020, 158.

79 See also Schuler 2016, 306.

The category of the micro-region is thus a promising tool with which to analyze (1) human-environment interactions and their impacts, and (2) the diversity of micro-regions including landscape, cities, and settlements and their relationships to each other at different scales and in a diachronic perspective.

In studies based on digital spatial analyses, there is a risk of geo- or eco-determinism, i.e., that anthropogenic structures and social conditions are caused and influenced by factors determined by nature.[80] Indeed, environmental data (e.g., digital elevation models, soil, geology, or water bodies) are usually used as the basis for analysis, and social and cognitive variables are not always integrated.[81] Since the micro-region is constituted by human behavior and human-environment interactions, it explicitly excludes the possibility of an eco-deterministic investigation or interpretation.[82]

In the context of this thesis, the risk of geo- or eco-determinism is countered by applying visual analyses (perception) and combining their interpretation with archaeological and historical information.[83] The category of micro-regions furthermore offers the advantage of incorporating both ancient historical-archaeological aspects and geographic aspects when examining relationships between humans and the natural environment across space. Political-administrative spaces such as the *chora*, military or economic territories, and natural spaces are considered and form levels of investigation and interpretation of a micro-region. The application of the category of micro-regions thus provides a conceptual framework that enables the interactions between humans and the environment outside the city of Pergamon to be addressed in all their contexts, going beyond the boundaries artificially set by merely geographical or historical-archaeological considerations.

80 Gaffney – van Leusen 1995, 367; Doneus 2013, 77.

81 Llobera 1996; Llobera 2001.

82 Zimmermann 2015b, 61.

83 See chapters 5.2 and 5.3.

2.3 Research History of the Pergamon Micro-Region

Early Research (End of the 19th and Beginning of the 20th Century)

In the 19th century, the ruins of ancient Pergamon were described in the reports of travelers and scholars interested in cultural history.[84] The discovery of fragments of marble reliefs, belonging to the Great Altar, by Carl Humann and subsequent excavations on the acropolis from the year 1878 onward mark a turning point in the academic research of Pergamon. In the early stages of research, the focus had already expanded from the acropolis and individual monumental buildings to the historical landscape of Pergamon, and various expeditions were carried out between the end of the 19th century and the beginning of the 20th century throughout the region.[85] At this time, Carl Schuchhardt had already come to the conclusion that the history of the city of Pergamon could only be understood if the surrounding landscape was also included in the research.[86] Accordingly, Pergamon was considered to be part of a historical landscape.

One particular focus of research was on historically well-documented settlements, such as Atarneus at the northwestern edge of the lower Bakırçay Plain. The ancient remains at the site on the present-day Kale Ağılı hill were described by Habbo G. Lolling as early as 1879, and several excavations followed in 1908 and 1911.[87]

Between Pergamon and the coast, the prominent Kalarga Tepe hill rises from the Bakırçay Plain.[88] Several expeditions and small excavations were carried out at its peak, leading to its identification as Teuthrania, the mythical predecessor of Pergamon.[89]

Further expeditions went to the cities of Perperene, in the Kozak Mountains northwest of Pergamon, and Aigai, in the Yunt Dağı Mountains southwest of Pergamon.[90] In Pitane (present Çandarlı), Siegfried Loeschke carried out an excavation in 1911, setting a basis for the investigation of pottery production and trade in the region.[91] Excavations continued in the 1960s, and an intensive ceramic survey was conducted in 2019 and 2020.[92] Several expeditions to Mamurt Kale, a temple dedicated to the Meter Kybele deity, in the Yunt Dağı Mountains and a subsequent excavation provided new insights into the ancient cults of the region.[93]

84 Texier 1862; Texier – Popplewell Pullan 1865; Choiseul-Gouffier 1842; Hallbauer 1893; Cockerell 1903; Kohl 2009.

85 Conze 1912, 61–143 (C. Schuchhardt).

86 Schuchhardt 1887, 1207; Conze 1912, 65 (C. Schuchhardt).

87 Lolling 1879; Dörpfeld 1910, 395; Schazmann – Darier 1912; Conze 1912, 119–122 (C. Schuchhardt).

88 In some publications, the notation 'Kalerga Tepe' is also used.

89 Conze 1887; Dörpfeld 1910, 394–395.

90 Perperene: Fabricius 1886; Bohn 1886. Aigai: Bohn 1889.

91 Loeschcke 1912.

92 Pirson 2020, 227–231 (P. Bes – A. Keweloh-Kaletta); Sliwka 2020 with further reading; Pirson 2021a, 287–294 (P. Bes – A. Keweloh-Kaletta).

93 Schuchhardt 1887, 1212; Conze – Schazmann 1911.

In the course of numerous expeditions through the surrounding landscape of Pergamon, many smaller archaeological sites were discovered and documented. In particular, the records of the prehistorian C. Schuchhardt are an irreplaceable source today because many sites are now in a poor state of preservation or must even be considered lost.[94]

In early research, particular attention was also paid to the ancient water pipelines that brought fresh water to Pergamon from all parts of the micro-region.[95] The importance of the water supply for the city is also reflected in the detailed report on the water pipelines in the first volume of 'Altertümer von Pergamon' in 1913.[96] These studies on Pergamon's water supply were again considerably extended at the turn of the millennium by Günther Garbrecht and later supplemented by Henning Fahlbusch and Kai Wellbrock.[97]

During the early research on the water supply, when very precise elevations of the terrain were important, it became particularly clear that an accurate cartographic survey of the surroundings of Pergamon was necessary. Heinrich Kiepert's map of Asia Minor provided a valuable cartographic basis for investigations in the vicinity of Pergamon.[98] W. von Diest's cartographic survey of the region, published in 1903, was later refined by O. Berlet through further fieldwork and published in 1912 as a map, together with the archaeological sites described by C. Schuchhardt.[99] During this time, similar maps were produced of the surroundings of other ancient cities in Asia Minor, such as Miletus and Ephesus.[100]

The work in Pergamon, however, went far beyond simple topographic mapping. Instead, a multi-disciplinary and diachronic approach was followed from the very beginning, combining archaeological research with geography and geology. Alfred Philippson's detailed geological and topographical mapping and descriptions of the landscape, for example, are still a valuable source for our understanding of the region.[101]

Based on these studies, a discussion evolved among early researchers concerning the course and estuary of the Bakırçay River. Wilhelm Dörpfeld developed the hypothesis that the estuary of the river was originally located near Atarneus, north of the Kane Peninsula, and that the alluvial fan of the Geyikli River[102] eventually blocked the Bakırçay River in antiquity.[103] This is supposed to have resulted in the formation of the marshland southwest of Atarneus that extended to Kalarga Tepe and was flooded at certain times of the year until the 19th century.[104] The 'Dörpfeld scenario' was discussed critically

94 Schuchhardt 1887; Schuchhardt 1888; Conze – Schuchhardt 1899; Conze 1912, 61–143 (C. Schuchhardt).

95 Gräber 1888; Conze – Schuchhardt 1899, 123–143.

96 Conze 1913b, 365–412 (F. Gräber).

97 Garbrecht 2001; Garbrecht 2004; Fahlbusch 2012; Fahlbusch 2014; Wellbrock 2016.

98 Kiepert 1890.

99 Diest 1903; Conze 1912, 35–42 (O. Berlet), 61–143 (C. Schuchhardt).

100 Wilski 1906; Schindler 1906.

101 Philippson 1902; Philippson 1910; Conze 1912, 43–60 (A. Philippson).

102 Old maps also show the names Asarboğaz Çayı and Sarıazmak for the Geyikli River and the name Arpalık Valley for the Geyikli Valley.

103 Dörpfeld 1910; Dörpfeld 1911; Dörpfeld 1912; Dörpfeld 1928.

104 Lolling 1879, 7–9; Diest 1889, 8.

throughout the long research history,[105] but it was only recently that geo-archaeological investigations could finally disprove Dörpfeld's hypothesis.[106]

Decline of Research During the 20th Century

The progressive approach of the early research was unfortunately not continued, and interest in the surrounding area of Pergamon declined rapidly in the following decades. The work of Kurt Bittel in the 1940s and in particular a prehistoric survey by Jürgen Driehaus in the 1950s, however, were exceptions and provided a basic overview of prehistoric settlement activity in the lower Bakırçay Plain.[107] Further exceptions include the excavations of the Seç Tepe[108] tumulus near Elaia in 1965 and the sanctuary of Kapıkaya in 1972.[109]

In the 1990s, only a few fieldwork campaigns studied the Madra River Delta in the western Kozak Mountains in terms of archaeology, environment, and cultural history.[110]

Intensification of Research Since 2006

Archaeological surveys and geo-archaeological research around the lower Bakırçay Plain did not begin until 2006.[111] In this context, however, the focus was set on the western part of the micro-region, leaving ancient sites such as Parthenion, Gambreion, or Apollonia still widely unnoticed. One exception is the ancient thermal bath of Allianoi, which was excavated in the run-up to the construction of a reservoir.[112] All the surveys followed an interdisciplinary approach combining various disciplines, such as archaeometry, geoarchaeology, geophysics, or ancient history.

One survey project aimed to study the rural settlement structure in the vicinity of Pergamon in the Hellenistic period. Field research between 2006 and 2012 provided a variety of insights into the different settlement areas of the micro-region and its various rural sites (i.e., settlements, farmsteads, or tower houses).[113] In Atarneus in particular, the work of the first generation of researchers was continued and

105 Diest 1889; Philippson 1911; Bittel 1950; von Gerkan 1956.

106 Schneider et al. 2013; Schneider et al. 2014.

107 Bittel 1950; Driehaus 1957.

108 Horn – Boehringer 1966, 477–478 (S. Kasper); Pirson 2012b, 225–227.

109 Nohlen – Radt 1978.

110 Lambrianides – Spencer 1998; Lambrianides – Spencer 2007.

111 'Elaia: Eine aiolische Polis als Subzentrum der hellenistischen Metropole Pergamon' (F. Pirson) and 'Landstädte, Dörfer und Gehöfte in der Chora des hellenistischen Pergamons' (M. Zimmermann) were funded within DFG-Schwerpunktprogramm 1209 'Die hellenistische Polis als Lebensform. Urbane Strukturen und bürgerliche Identität zwischen Tradition und Wandel' (2006–2012). 'The Maritime Topography of the Ancient Kane Peninsula: A Micro-Regional Approach to the Impact of Harbours and Anchorages on Politics, Economy and Communication of a Western Anatolian Landscape. Kane Regional Harbour Survey (KRHS) 2014–2018' (F. Pirson) was part of 'Portus Limen – Rome's Mediterranean Ports' (S. Keay) and financed by the European Research Council (European Union's Seventh Framework Programme FP7/2007–2013). 'Die Transformation der Mikroregion Pergamon zwischen Hellenismus und römischer Kaiserzeit' (2019–today, F. Pirson, B. Schütt, T. Schulz-Brize) is an ongoing project funded by the German Research Foundation (DFG).

112 Müller 2004; Yaraş 2006.

113 Pirson – Zimmermann 2014; Zimmermann et al. 2015.

yielded new insights into the development and decline of the city. The results published to date, however, offer only a glimpse in comparison to the size of the study area.

Another survey project investigated Elaia and its vicinity. Based on fieldwork between 2006 and 2013, the city and its harbor structures could be reconstructed, and the great importance of the harbor for the economic and military strategy of Pergamon, especially after its integration into the territorial sphere of power of the Attalid rulers, became evident.[114] Here, too, the interdisciplinary studies focused largely on the harbor site and its immediate surroundings.

A survey directed by Barbara Horejs continued the work of J. Driehaus and K. Bittel between 2008 and 2014 and expanded our knowledge about general prehistoric settlement patterns in the lower Bakırçay Plain.[115]

The maritime topography of the ancient Kane Peninsula was a key aspect of research between 2014 and 2017 in the context of the Kane Regional Harbor Survey.[116] It was the first time in the region that a larger, contiguous landscape unit was focused on in its entirety. The harbor sites of Kane and Pitane as well as other landing sites and bays along the coast of the Kane Peninsula were investigated. In addition to Roman Imperial villas or thermal baths on the coast and on the offshore island of Elaioussa, fortresses, settlements, and ancient roads were documented, creating preliminary impressions of the ancient coastal landscape.

Due to construction work and illicit digging activities, several emergency measures have had to be taken by the Pergamon Excavation Project in cooperation with the Bergama Museum in recent years. Rescue excavations of the Taşdam Tepe necropolis and the natural sanctuary on Molla Mustafa Tepesi, for example, led to new insights into the sacred landscape of the micro-region.[117]

All the surveys and excavations contributed to the expansion of the archaeological data set of the western micro-region and were accompanied by extensive geo-archaeological investigations. The study of the ancient harbor of Elaia, for example, was embedded in geo-archaeological research focused on Holocene sea level changes, spatiotemporal coastal displacements, and vegetation changes in the Elaia area.[118] Further research on vegetation changes and human impact was carried out, evaluating a sediment core from Kara Göl Crater Lake in the Kara Dağı Mountains.[119]

Geo-archaeological research was also conducted in the vicinity of the ancient harbor of Kane and the Arginusae Islands. The islands are mentioned in the context of the Peloponnesian War as a naval base

114 Most recently Pirson et al. 2015; Feuser et al. 2018; Seeliger et al. 2019; Feuser et al. 2020.

115 Most recently Horejs 2014; Pavúk – Horejs 2018.

116 Most recently Pirson 2018, 150–167 (S. Feuser – E. Laufer); Laufer 2020.

117 Pirson 2012b, 241–248 (V. Stappmanns); Kelp 2020 (Taşdam Tepe); Pirson 2013, 131–133; Ateş 2014, 426–431(Molla Mustafa Tepe).

118 Seeliger et al. 2012; Seeliger et al. 2013; Seeliger et al. 2014; Pint et al. 2015; Shumilovskikh et al. 2016; Seeliger et al. 2017; Seeliger et al. 2019.

119 Pirson 2021a, 300–309 (L. Shumilovskikh – M. Seeliger – H. Brückner).

and the scene of a naval battle in 406 BC.[120] Written sources mention three Arginusae Islands; the map of Piri Reis from 1521, however, shows only two islands.[121] Drillings conducted in 2015 finally detected a sound that once separated the peninsula from the mainland and thus revealed the third Arginusae Island.[122]

Further interdisciplinary investigations were also carried out in the vicinity of archaeological sites, such as Atarneus or Yeni Yeldeğirmentepe in the Bakırçay Plain, between 2008 and 2012.[123]

The Bakırçay River as a formative element of the entire landscape has also been the focus of geo-archaeological research. In addition to the previously mentioned studies on the question of the river's estuary (the 'Dörpfeld scenario'), further investigations were carried out in the plain east of Teuthrania. On the basis of drilling cores and sediment outcrops in the vicinity of an ancient building complex, aspects of the river dynamics and their relation to the settlement history were studied.[124]

Individual aspects of the Pergamon Micro-Region have been studied independently from the fieldwork described above, especially since the early 2000s. The main focus has been on the relationship between rural sanctuaries and the city of Pergamon and on the evaluation of historical sources concerning the boundaries, settlement structure, economy, defense, and road network of the *chora* of Pergamon.[125] Most recently, the importance of visual aspects for the study of the micro-region and its relationship to the city has also become a focus of research.[126]

In 2019, a new and ongoing interdisciplinary research project studying the 'Transformation of the Pergamon Micro-Region between the Hellenistic and the Roman Imperial Period (TransPergMikro)' began.[127] Building on the foundation of previous research, this project provided an opportunity for the comprehensive landscape archaeological study of the Pergamon Micro-Region for the first time. This moves the spatial focus away from the small-scale analyses of individual, exemplary sites of previous projects to a micro-regional study. It advances interdisciplinary collaboration in the investigation of Pergamon's surroundings by expanding traditional ways of working with new data sets and spatial analyses from different fields of research.[128] This thesis is thus able to open up entirely new possibilities in terms of analyzing and interpreting past human-environment interactions in the Pergamon Micro-Region, while providing a research approach that could be applied to the study of other Hellenistic-Roman cities in Asia Minor and beyond.

120 Thucydides 8, 101, 2; Xenophon, Hellenica 1, 26, 27–34; Diodorus 13, 97–99; Pirson 2016, 189 (M. Seeliger – A. Pint – M. Herbrecht – H. Brückner); Laufer 2020, 220 with note 25; chapter 5.2.

121 Kahle 1926.

122 Pirson 2016, 185–190 (M. Seeliger – A. Pint – M. Herbrecht – H. Brückner).

123 Atarneus: Schneider et al. 2013; Schneider et al. 2014; Yeni Yeldeğirmentepe: Schneider et al. 2017.

124 Schneider et al. 2015; Pirson 2020, 223–227 (F. Becker – D. Knitter – X. Yang – B. Schütt).

125 Sanctuaries: Wulf 1999; Agelidis 2009; Agelidis 2012; Ateş 2014. Historical sources: Sommerey 2008; Müller 2010; Tozan 2017; Schneider 2021b.

126 Williamson 2016; Pirson – Ludwig (in press).

127 See note 3 and Pirson 2020.

128 See, e.g., chapter 5.3.

3. Study Area

The ancient city of Pergamon is the spatial starting point of this thesis. Its ruins and its successor, the present-day city of Bergama, are located in Türkiye's Aegean region, about 25 km inland on the northern edge of the lower Bakırçay Plain (27°11'0.46"E, 39°7'58.25"N) (Figs. 1.1, 3.1). The thesis examines the ancient landscape surrounding the city of Pergamon by using the category of micro-regions. Although the extent of a micro-region is not limited by geographic boundaries and can change dynamically, the study area of this thesis' analyses and case studies can be specified as follows:

It comprises the Bakırçay Plain and its estuary, the Kozak and Madra Dağı Mountains (ancient Pindasos, 1,343 m a.s.l.), the Gölçük Mountains (937 m a.s.l.), the Yunt Dağı Mountains (ancient Aspordenon, 1,076 m a.s.l.), the Kara Dağı Mountains (ancient Kane, 772 m a.s.l.), as well as the coast along these mountains (Figs. 3.1–3.5).[129] The center of the study area is the east-west trending lower Bakırçay Plain, through which the eponymous river flows. The Bakırçay River (ancient Kaikos) originates in the Gölçük Mountains and flows through the upper, middle, and lower Bakırçay Plain before draining into the Aegean Sea in the Gulf of Çandarlı.[130] Given the current state of research and data availability, this thesis focuses primarily on the western lower Bakırçay Plain, the adjacent mountains, and the coast. For the reconstruction of ancient routes in chapter 5.1 and the analysis of harbors in chapter 5.2, individual sites beyond the core study area had to be included. The maximum extent of the study area between Ergasteria in the north (27°35'47.19"E, 39°43'39.51"N), Hadrianoutherai in the east (27°54'38.81"E, 39°36'24.10"N), Magnesia in the south (27°26'15.48"E, 38°37'9.47"N), and Mytilene in the west (26°33'19.05"E, 39°6'37.79"N) thus covers ca. 14,358 km² (Fig. 3.1).

129 Elevations: The elevations given in the case studies still refer to general Pergamon literature and old topographic maps, e.g., Conze 1912 (O. Berlet). The elevations given here are to be used in the future and are based on the Active Fault Map Series of Turkey published by the General Directorate of Mineral Research and Exploration, Ankara, Türkiye. See Emre et al. 2011a; Emre et al. 2011b; Emre – Özalp 2011.

Notations: In some publications, the Bakırçay Plain is called a valley for historical or semantic reasons, although it is geomorphologically and geologically a sediment-filled graben, i.e., an alluvial plain. Due to the long research history and lack of officially published maps, the following notations can also be found in other studies: Madra Dağı: Madradağ(ı); Yunt Dağı: Yund Dağ(ı), Yünd Dağ(ı), Yünt Dağ(ı); Kara Dağı: Karadağ(ı); Bakırçay: Bakır Çay(ı). See also Yang et al. 2021, 4.

130 On the spatial structure of the upper, middle, and lower Bakırçay Plain, see Tozan 2017; Ludwig 2020; Yang et al. 2021.

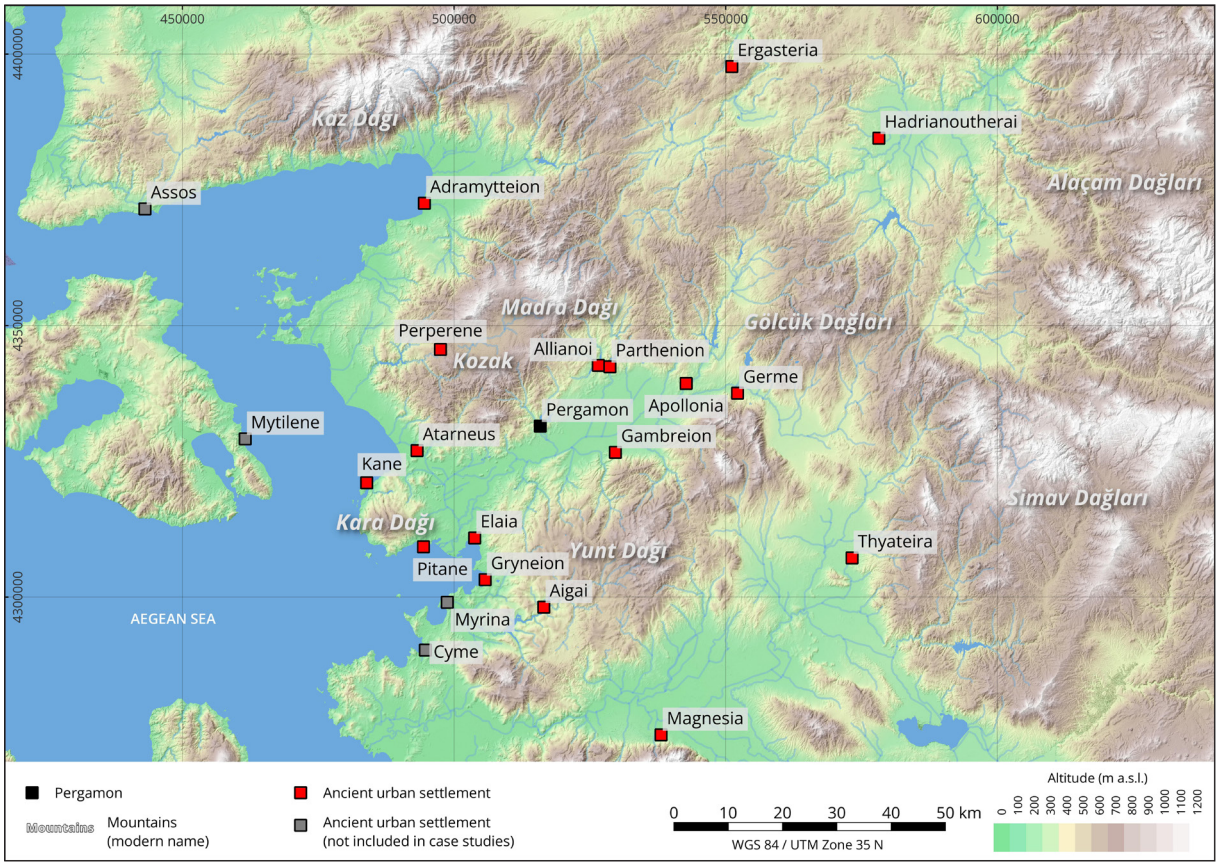

Fig. 3.1 Study area of this thesis.

Fig. 3.2 The western lower Bakırçay Plain and the city hill of Pergamon in the background. View from Eğrigöl Tepe (Photo location: 27°6'43.49"E, 39°3'34.35"N).

Fig. 3.3 View from the Yunt Dağı Mountains across the slightly hidden lower Bakırçay Plain to the Kozak Mountains. In the background on the right, the houses of present-day Bergama and the ancient city hill of Pergamon can be seen. View from Büyüksofulu Tepe (Photo location: 27°7'31.18"E, 38°59'58.88"N).

Fig. 3.4 Eastern Kara Dağı Mountains. The summit plateau of Hatipler Kalesi lies in the sun on the right. View from Emirali Tepe (Photo location: 26°57'4.29"E, 39°1'26.59"N).

Fig. 3.5 View over the Gulf of Çandarlı with the peninsula of ancient Pitane (modern Çandarlı) in the foreground and the Bay of Elaia in the background (left), in front of the foothills of the Yunt Dağı Mountains (Photo location: 26°53'42.37"E, 38°56'41.22"N).

3.1 Geotectonic and Geological Setting

The complex landform characteristics of the study area are influenced by geotectonic processes, volcanism, and the resulting geologic formations, along with alluvial processes evident, for example, in the lower Bakırçay Plain or the Bergama alluvial fan. From a geotectonic perspective, the Pergamon Micro-Region is part of the westward-drifting Aegean-Anatolian microplate and is located at the southwestern edge of the Sakarya Zone and the northern part of the Bornova Flysch Zone, which are separated by the continental Izmir-Ankara Suture Zone.[131] Due to tectonic stresses, a formation of horst and graben structures was formed in the study area, mainly from the middle Miocene to the early Pliocene.[132] This was made up of the Kozak Horst in the north and the Maruflar Horst in the south, the large Ayvalık-Lesvos and Bergama graben structures, as well as smaller grabens including the Zeytindağ and the Değirmendere grabens (Fig. 3.6).[133] The Kara Dağı Massif consists mostly of volcanic rock and was uplifted during the Pliocene or later.[134] The hills rising from the lower Bakırçay Plain, such as Kalarga Tepe (Teuthrania, 165 m a.s.l.) or Eğrigöl Tepe (Halisarna, 114 m a.s.l.), are Miocene volcanic domes.[135] Thus, the present-day horst and graben structures within the study area are the result of tectonic processes overprinted by volcanic structures.

This is also reflected in the geological formations of the study area. The Kozak and Madra Dağı Mountains are largely composed of granodiorite rocks surrounded by metamorphic, carbonate/clastic, and volcanic rocks, such as andesite, basalt, greywacke, limestone, and scattered formations of marble. Pyroclastic rocks, such as andesite and tuff, dominate the Yunt Dağı Mountains. The Kara Dağı Massif rises in the west and consists of volcanic rocks, mainly andesite. [136]

131 Okay 2008; Sangu et al. 2020; Yang et al. 2021.

132 Yılmaz et al. 2000.

133 Altunkaynak – Yılmaz; Kuzucuoğlu et al. 2019; Sangu et al. 2020; Yılmaz et al. 2000.

134 Sangu et al. 2020.

135 Borsi et al. 1972; Yang et al. 2021.

136 Philippson 1902; Conze 1912, 43–60 (A. Philippson); most recently Yang et al. 2021.

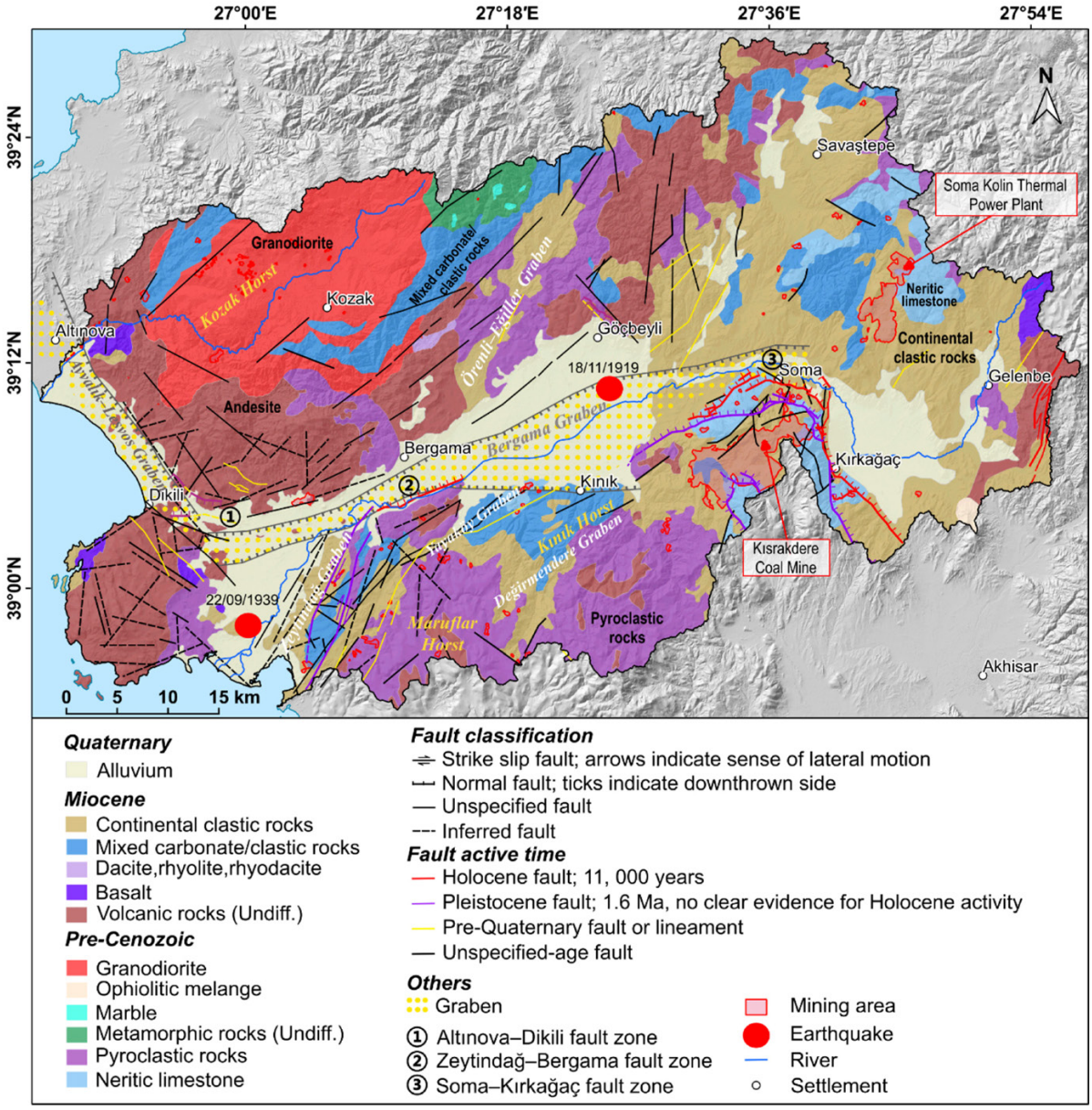

Fig. 3.6 Geological map of the Bakırçay and Madra River catchments and their adjacent coastal areas (Yang et al. 2021).

3.2 Relief

The heterogeneous relief of the study area is composed of mountains, plains, and the coastal zone. Yang et al. describe the asymmetry of the relief between the Kozak Mountains to the north and the Yunt Dağı Mountains to the south of the lower Bakırçay Plain as a characteristic of the Pergamon Micro-Region.[137]

The Kozak and Madra Dağı Mountains rise immediately north of the ancient city hill of Pergamon (Figs. 1.1, 3.1). They are characterized by a steep relief with slope inclinations averaging 18° and local maxima of 80°.[138] The heterogeneity of the relief is also reflected in the predominant landform types: ridges, spurs, slopes, hollows, and valleys.[139] One exception, however, is the Kozak interior plain, which forms an intramontane basin of about 25 km² with a gentle relief. In contrast to the Kozak Mountains, the Yunt Dağı Mountains in the south of Pergamon are characterized by a less pronounced relief. The slopes of the northwestern mountains (along the Zeytindağ and Yayaköy grabens) are less steep on average, and the Maruflar Horst, the highest area in the Yunt Dağı Mountains, is shaped by wide and extensive ridges and slopes.[140] Only the eastern part of the mountain range (Kınık Horst and Değirmendere Graben) is characterized by a more pronounced relief, consisting of steep slopes and narrow, deeply incised valleys. The main mountain ranges are separated by the lower Bakırçay Plain, an east-west trending graben (Bergama Graben), which is constantly aggraded by the alluvial deposits of the Bakırçay River, its tributaries, and piedmonts and alluvial fans along the mountains.[141] The lower Bakırçay Plain has largely flat relief (Figs. 1.1, 3.1). The volcanic hills that protrude from the plain, such as Kalarga Tepe or Eğrigöl Tepe, are exceptions; they appear particularly distinctive and were settled in ancient times. Ancient Pergamon, on the other hand, is located on a promontory in front of the Kozak Mountains. Only the Roman lower city and the present-day city of Bergama lie on the Bergama alluvial fan, which receives sediments carried by the Bergama River (ancient Selinos) and the Kestel River (ancient Ketios) from the Kozak Mountains and extends southward into the plain.

Due to their location on the Kane Peninsula, the Kara Dağı Mountains represent a distinctive feature of the study area (Figs. 1.1, 3.1). They separate the lower Bakırçay Plain from the coast, with the exception of two narrow corridors. The eastern part of the mountain range is characterized by more gentle slopes and narrow, elongated valleys. The western mountain range, on the other hand, is characterized by extensive and steeper slopes that merge into a cliff coastline.[142]

137 Yang et al. 2021, 1.

138 Schneider 2014, 20; Yang et al. 2021, 12.

139 Yang et al. 2021, 12.

140 Schneider 2014, 20; Yang et al. 2021, 14–15.

141 Yang et al. 2021, 18.

142 Yang et al. 2021, 11.

3.3 Climate

The Pergamon Micro-Region has a Mediterranean climate today, characterized by wet and mild winters and hot and dry summers, 'Csa' according to Köppen and Geiger classification.[143] In the period between 1981 and 2010, Bergama had an average temperature of 14.7 °C and an average annual precipitation of 749 mm (Fig. 3.7). In comparison, Dikili, located on the west coast, had a slightly warmer and drier climate with an average temperature of 16.2 °C and an average annual precipitation of 711 mm (Fig. 3.7).[144] Seasonality is the most dominant and distinctive character of the region. In July and August, the average temperatures are above 25 °C, and January is the coldest month with average temperatures between 6 and 8°C. In addition, the climate is characterized by mild and humid seasons and hot and dry seasons. In both places, most rain fell in January and December, while the dry period lasted from May to October.[145]

Due to thermal high pressure over the Turkish landmass and relatively low air pressure over the Aegean Sea, strong easterly winds are generated and flow through east-west trending grabens such as the Bakırçay Plain.[146] Today, this is evidenced by the numerous wind turbines in the western lower Bakırçay Plain, on Geyikli Dağı, and in particular in the Yunt Dağı Mountains.

Ancient building activities are also associated with this phenomenon. The exposed summit of the city hill of Pergamon, and especially the palaces, were protected on their north and east sides by a high wall, whose great height makes little sense from a fortification point of view and is therefore associated with protection from the strong winds.[147] Conclusions about climatic conditions in antiquity can also be drawn from the examined bones of human individuals from Pergamon. The regular occurrence of chronic sinusitis, for example, is associated with the living conditions and cold and humid winters of antiquity.[148]

In general, climatic conditions in the eastern Mediterranean were wetter and warmer in the early Holocene than in the subsequent phases of the middle and late Holocene, when the climate gradually became drier.[149] In addition, abrupt and rapidly changing climate events occurred around 8.2, 4.2, and 3.2 ka BP.[150] Hydro-balance models for Lake Simav (150 km straight-line distance east of Pergamon) assume annual precipitation of below 460–478 mm for these dry events, whereas today it is about 800 mm.[151] For the post-250 BCE phase, Lake Simav proxies indicate a high lake level and high precipitation, which

143 Peel et al. 2007; Turunçoğlu et al. 2018, 27.

144 Yang et al. 2021, 6.

145 Kuzucuoğlu 2019.

146 Erlat 2007, 53–54.

147 Radt 2016, 53–54.

148 Pirson 2013, 141 (W.-R. Teegen).

149 Kuzucuoğlu 2002; Dormoy et al. 2009.

150 '8.2 ka event': Pross et al. 2009; Flohr et al. 2016. '4.2 ka event': Weiss 2016; Bini et al. 2019. '3.2 ka event': Kaniewski – van Campo 2017.

151 Ocakoğlu et al. 2022.

Ocakoğlu et al. suggest is consistent with the 'Roman Climatic Optimum' in the Mediterranean, i.e., with the stable, warm, and humid conditions prevalent between roughly 250 BCE and 400 CE.[152]

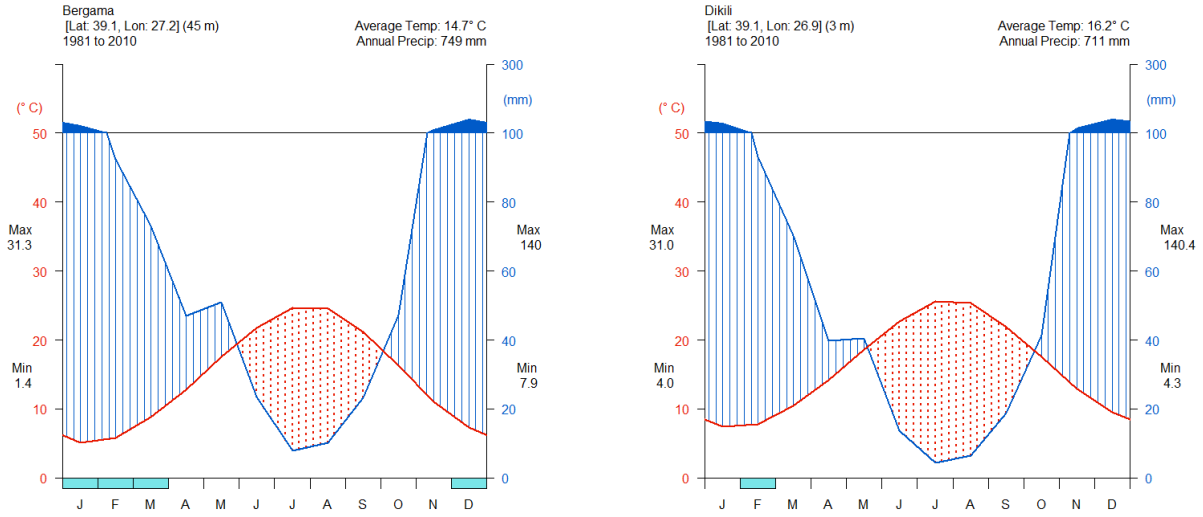

Fig. 3.7 Climate diagrams of Bergama and Dikili (reference period: 1981–2010; Yang et al. 2021).

152 Ocakoğlu et al. 2022. On climatic conditions in the Roman Imperial period, see, e.g., McCormick et al. 2012; Harper – McCormick 2018.

3.4 Soils and Vegetation

A wide range of soils form in the different local areas of the region, among other things due to the described heterogeneity of the relief. The following classification therefore describes the predominant soils in the respective areas. In the Kara Dağı Mountains, in addition to the brown forest soils, podzolic soil material also prevails. Alluvial soils predominate in the Bakırçay Plain, the coast north of Dikili, and in the Gulf of Çandarlı.[153] As in the Kozak and Madra Dağı Mountains, brown forest soils dominate in large parts of the Yunt Dağı Mountains.[154] In the northwestern and western foothills, however, terra rossa soil material predominates. In the lower elevations of the eastern Madra Dağı and Yunt Dağı Mountains, in the area of the middle and upper Bakırçay Plain, noncalcic brown and rendzina soil materials also occur.[155]

The natural vegetation of the Pergamon Micro-Region is only preserved in a few areas today.[156] Due to human impact, the lower hillsides of the Kozak Mountains are characterized by transitional woodland shrubs and sclerophyllous vegetation. At elevations above 500 m a.s.l., dense coniferous forest is dominant in the Kozak and Madra Dağı Mountains (Figure 3.8).[157] The Kozak intramountainous basin is dominated by cultivation patterns of fruit trees, cultivated pines, and farmland in combination with natural vegetation. A different vegetation cover can be observed in the Yunt Dağı Mountains south of Pergamon and in the Kara Dağı Mountains on the Kane Peninsula. Sclerophyllous vegetation, woodland shrubs, and grasslands are widespread in these areas (Figure 3.9). Today, the Bakırçay Plain is almost entirely used for agriculture.

The agricultural use of the plain around Pergamon dates back to antiquity. Grain cultivation in the region was already mentioned by Herodotus in the 5th century BCE, and the plain's fertility was praised by Strabo in the 1st century BCE.[158]

153 Danacıoğlu – Tağıl 2017.

154 Erlat 2007.

155 Danacıoğlu – Tağıl 2017.

156 Hütteroth – Höhfeld 2002, 95; Yang et al. 2021, 7.

157 Atalay 2018; Yang et al. 2021.

158 Herodotus 6, 4; Strabo 13, 4, 2; Pirson – Zimmermann 2014, 144; Sommerey 2008, 159–164.

Fig. 3.8 Coniferous forest and steep relief in the Kozak Mountains south of the village of Yukarıbey (Photo location: 27°4'11.64"E, 39°10'59.83"N).

Fig. 3.9 Sclerophyllous vegetation, woodland shrubs, and grasslands in the Yunt Dağı Mountains (Photo location: 27°6'16.68"E, 38°59'47.56"N).

3.5 Hydrological Setting

The study area is mainly characterized by two perennial rivers: In the north, the Madra River drains large areas of the Madra Dağı Mountains and the intramontane Kozak Basin to the west (Fig. 1.1). Its catchment area covers approximately 382 km².[159] At Altınova, the river flows into the Aegean Sea, where it forms a delta on the littoral plain.[160] The Bakırçay River originates in the Gölçük Dağları Mountains and flows through the upper and middle Bakırçay Plain to Soma (Fig. 1.1). It finally flows through the Bergama Graben and the lower Bakırçay Plain and is a typical example of the rivers that interact with the east-west trending grabens on the Turkish Aegean coast. The Bakırçay River flows through the lower Bakırçay Plain in a west-south-west direction. It passes the Bergama alluvial fan in the middle of the lower plain and flows along the foothills of the Yunt Dağı Mountains before entering the Aegean Sea, where its deposits form a delta between Çandarlı and Zeytindağ. Its catchment area covers approximately 3,382 km² and is thus much larger than that of the Madra River.[161] The Bakırçay River is fed by several tributaries. The Bergama River flows west and the Kestel River east past the ancient city hill of Pergamon before flowing jointly into the Bakırçay River. The last tributary just before the river mouth is the Geyikli River, which drains the Geyikli Valley in the southern foothills of the Kozak Mountains.

The natural hydrological pattern has been greatly altered in recent decades. On the one hand, this is evident from the construction of dams, such as the Çaltıkoru Baraj and the Yortanlı Baraj north of Ayaskent or the Kestel Baraj directly northeast of the ancient city hill of Pergamon. On the other hand, the rivers in the plain are strongly regulated by canals, river straightening, and embankments. Flooding of the plain, as it still occurred until the beginning of the 20th century, especially between Kalarga Tepe (Teuthrania) and Atarneus, east of Dikili[162], is significantly reduced today.

In the area of the Kozak Mountains and the Kara Dağı Mountains, especially on its west front, numerous thermal springs occur.[163] Their hot water was already being used in antiquity to supply thermal baths.[164]

The sea and the long coastline are also defining elements of the Pergamon Micro-Region. Sea level changes have affected access to and use of coastal landing sites and harbors over time. According to geo-archaeological investigations, the postglacial marine transgression approached the Bay of Elaia in around 5500 BCE, reaching its maximum level in around 1500 BCE when the coastline was about 1 km further inland than it is today. Increased settlement pressure in the area and the resulting increased erosion are associated with the seaward shift of the coastline from about 850 BCE, which eventually led to the abandonment of the harbor of Elaia.[165]

159 Yang et al. 2021, 4.

160 Lambrianides – Spencer 2007.

161 Yang et al. 2021, 4.

162 Diest 1889, 8; Lolling 1879, 7–9.

163 Jeckelmann 1996.

164 See chapter 5.2 for thermal springs and baths on the coast and appendix A.4 for an ancient thermal bath in the Geyikli Valley.

165 Most recently Seeliger et al. 2019.

3.6 Settlement History and Ancient Land Use

The settlement history of the Pergamon Micro-Region is first traceable in a cave in the southwestern Kozak Mountains (ancient Pindasos) that was recently discovered during an archaeological survey in 2020.[166] The cave served as a seasonal living and production site for a group of hunter-gatherers as early as the Epipaleolithic, about 14,000 years ago, and was even used as a sanctuary for the Meter Kybele cult between the 6th century BCE and the Roman Imperial period.

Until the discovery of the above-mentioned cave, finds in the Gümüş Valley, southeast of Pergamon, were considered the oldest evidence of settlement activities in the Pergamon Micro-Region, dating back to the phase between the Late Neolithic and Middle Chalcolithic (7th–5th millennia BCE).[167] In the Late Chalcolithic and Early Bronze Age (4th–3rd millennia BCE), only a few natural mounds in the Bakırçay Plain and along the coast were settled; later on, these included Elaia. The majority of prehistoric settlements in the Pergamon Micro-Region, however, date to the Middle and Late Bronze Age (2nd millennium BCE), including places later known as Atarneus, Pitane, Teuthrania, Eğrigöl Tepe, or Hatipler Kalesi (Fig. 3.10).[168] The earliest evidence of human (settlement) activity on what would become the city hill of Pergamon dates from around the same time.[169]

Little is known about the settlement structure of the Pergamon Micro-Region during the following centuries. A few written sources indicate that large Persian estates existed, at least in the eastern plain, from about the 6th century BCE onwards.[170]

In the western micro-region, Elaia and Pitane developed into supra-regional harbor towns by the 5th century BCE, when they were first mentioned in the lists of the Attic Maritime League.[171]

At the transition from the 5th to the 4th century BCE, the first evidence of local rulers in the Pergamon Micro-Region becomes apparent.[172] Pergamon was seat of the Gongolyd rulers, a Greek dynasty, who themselves were under Persian suzerainty.[173] Other Greek dynasties established themselves nearby, for example at Teuthrania and Eğrigöl Tepe.[174] Small fortresses like those on Zindan Kayası or on the recently discovered Zindan Tepe in the southeastern foot slopes of the Kara Dağı Mountains (ancient Kane) are also associated with such local dynasties.[175]

166 Pirson 2021a, 268–273 (Z. M. Aksan – B. Ludwig – F. Pirson), 273–274 (Ateş), 274–275 (T. Doğan).

167 Horejs 2014, 113, Figure 5; Pirson 2015, 136 (B. Horejs – B. Milić – P. Pavúk).

168 Horejs 2010; Horejs 2014; Pavúk – Horejs 2018; on prehistoric settlements in general, see also Bittel 1950; Driehaus 1957.

169 Hertel 2011; Kästner 2011, 28 with notes 3 and 4; Horejs 2014, 108–109.

170 Xenophon, Anabasis 7, 8, 9 ff.; Conze 1912, 110 (C. Schuchhardt); Conze 1913a, 13, 161–162; Sommerey 2008, 137–139.

171 Heinle 2015, 105.

172 Kelp 2020.

173 Hansen 1971, 8–13; Sommerey 2008, 136; Pirson 2017, 51.

174 Heinle 2015, 104.

175 Pirson 2012b, 222–225; Pirson 2017, 52–53; Zindan Tepe: Pirson (in press) (B. Ludwig – F. Pirson – Z. M. Aksan – G. Ateş – W. Rabbel – E. Erkul – İ. Kaplanvural).

In the course of the 4th century BCE, independent *poleis* had initially developed in the micro-region, each with its own *chora*,[176] including Pergamon, Kane, Pitane, and Elaia; later even Mytilene on Lesbos claimed land in the western micro-region (Fig. 3.10).[177] In particular, Atarneus was of great importance at this time, being the residence of the Greek tyrant Hermias.[178]

Beyond these larger towns, little is still known about rural settlements. A few clues were provided by an inscription found at present-day Poyracık (ancient Gambreion), which dates to the eleventh regnal year of Alexander III of Macedon (326/5 or 325/4 BCE). The text records the conveyance of land in the Bakırçay Plain from a Krateuas to a certain Aristomenes.[179] The land included arable land, a house plot, and a garden.

In 282 BCE, Philetaerus took power in Pergamon by deserting Lysimachus, a successor of Alexander III of Macedon, and established the rule of the Attalids.[180] This step in the early 3rd century BCE also marks the approximate beginning of the study period of this thesis. In the following years of Attalid rule, the city of Pergamon developed enormously as their royal residence. Monumental buildings, such as the Great Altar or the Great Gymnasium, were erected on the city hill and the fortified residential area was massively expanded from 21 to 91 ha in the 2nd century BCE.[181]

The Attalid rulers' striving for power and influence and the threat posed by the Galatians led to warlike conflicts and decades of unrest, which also had an impact on the aforementioned *poleis* and the rural settlements within the Pergamon Micro-Region. This is particularly evident in Elaia, which was developed into the Attalids' main harbor and naval base and thus secured Pergamon's access to the sea.[182] The need for protection as a result of the political turmoil and military conflicts in this period is also reflected in numerous fortified settlements and fortresses, such as Hatipler Kalesi, Serhat Tepe, Eğrigöl Tepe, Memeli Tepe, Dede Tepe, and Kuyulu Kaya (Fig. 3.10).[183]

In addition to the *poleis* and fortified sites, numerous farmsteads, hamlets, and rural villages existed in the Hellenistic period and were scattered throughout the micro-region.[184] Their size, density, and typology, as well as their relationship to Pergamon, however, remain difficult to assess. A characteristic settlement type in this period was the *Turmgehöft*, the presence of which is particularly well-documented in the Kara Dağı Mountains.[185] It usually consisted of a central tower building as well as outbuildings

176 Sommerey 2008, 136.

177 Schneider 2021a; Schneider 2021b.

178 Heinle 2015, 113; Zimmermann et al. 2015, 194–207. On farmsteads and a rural village in the immediate vicinity: Zimmermann et al. 2015, 208–209.

179 Sommerey 2008, 151–152; Thonemann 2009.

180 Hansen 1971, 15–22; Marek – Frei 2017, 273–276; Gehrke 2018.

181 Pirson 2017, 70.

182 See chapter 5.2 and most recently Feuser et al. 2020.

183 See chapter 5.3 with further reading.

184 See appendix A.3 for new sites that have most recently been discovered in the Tekkedere Valley and the Çalıbahçe Basin. See also Sommerey 2008, 152–155; Zimmermann et al. 2015, 208–209.

185 See chapter 5.3. For a discussion on the functional classification of these sites, see also most recently Laufer 2021, 51–54.

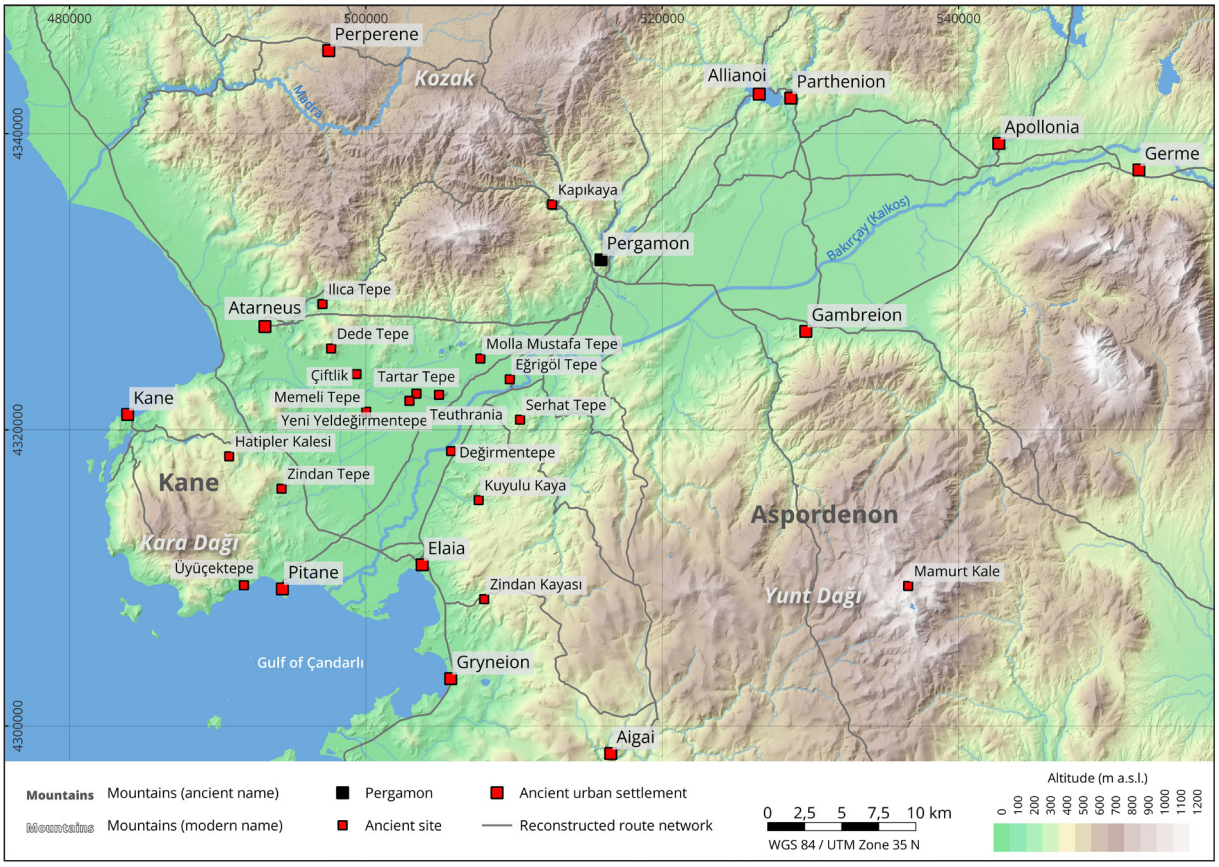

Fig. 3.10 Lower Bakırçay Plain and adjacent mountains with ancient sites and reconstructed route network.

and had either a military or an agricultural function. These estates were probably in the tradition of the previously mentioned and also fortified large Persian estates.

It is generally assumed that the settlement structure of the Pergamon Micro-Region changed during the eventful period beginning with the testamentary transfer of the Attalid Empire to Rome by Attalus III (133 BCE), including the establishment of the Roman province of Asia under the first governor Manlius Aquilius (129 BCE), and lasting until the Roman Imperial period around the 1st century CE.[186] Numerous fortified places and fortresses, including Atarneus, Hatipler Kalesi, Teuthrania, Eğrigöl Tepe, Memeli Tepe, and Serhat Tepe, were abandoned. This is usually associated with the consequences of the Aristonicus Revolt (133–129 BCE) and the sanctions imposed by Rome as a result of the 1st Mithridatic War (89–85 BCE).[187] A comprehensive study of this potentially fundamental change in the settlement structure has so far been lacking, and only the case study in chapter 5.3 was able to shed new light on this topic.

Toward the end of the 1st century BCE, Pergamon expanded from the city hill southward into the plain.[188] During the Roman Imperial period, numerous large buildings were erected, including the 'Red Hall,'

186 On the eventful period in Pergamon, see Marek – Frei 2017, 324–355.

187 Pirson 2010, 181–182 (M. Zimmermann); Pirson 2011, 152–153, 158 (M. Zimmermann); Zimmermann et al. 2015, 214; Pirson 2017, 92–96. On the Aristonicus Revolt in general, see, e.g., Daubner 2006; Marek – Frei 2017, 324–326, and on the 1st Mithridatic War, see, e.g., Marek – Frei 2017, 345–355.

188 Pirson 2017, 97, Figure 39.

a sanctuary for the Egyptian deities, as well as the stadium, theater, and amphitheater at Musalla Mezarlığı, and the temple of Trajan (Trajaneum) on the summit of the city hill.[189]

It is assumed that the scattered settlement of farmsteads, hamlets, and rural villages in the countryside presumed for the Hellenistic period persisted in the Roman Imperial period. This assumption, however, is primarily based on few and imprecisely dated rural settlements.[190] Apart from harbor cities and those very few rural settlements, the main sites documented so far from the Roman Imperial period were thermal baths on the coast south of Kane, in the Geyikli Valley east of Atarneus, and in Allianoi northeast of Pergamon, as well as a coastal villa (*villa maritima*) on the island of Elaioussa.[191]

Some additional information about the rural settlements can be found in the written records of Galen, who grew up in Pergamon and whose father owned a rural estate. He describes two different types of ordinary rural houses in the 2nd and 3rd century CE: a simple house type consisting of a single room with a fireplace in the center and a larger house type with a central room and several side rooms as well as a second floor.[192] The number, distribution, and density of such estates, however, so far remain unknown. Galen furthermore provides information on the (rural) population by very briefly describing the number of inhabitants of Pergamon. For the 2nd–3rd century CE, he gives a population of 120,000, to which children and foreigners are generally added, assuming a total population of 160,000–180,000 for the city and surrounding territory.[193]

The results of recent surveys now also indicate an emergence of large and architecturally elaborate farmsteads and villas in the Roman Imperial period. They have so far been found in the western lower Bakırçay Plain near Teuthrania, on the southern edge of the plain near present-day Tekkedere, in the foothills of the Yunt Dağı Mountains (ancient Aspordenon) between the present-day villages of Bozköy and Eğrigöl Köy, and probably also on the edge of the Çalıbahçe Basin in the Yunt Dağı Mountains.[194]

In line with the project into which this thesis is integrated, the chronological focus ends in the 3rd century CE with the reorganization of the Roman political system under emperor Diocletian.[195]

Between the 3rd and 7th century CE, a reduction of settlement activities on the city hill of Pergamon is assumed.[196] In the 7th century CE, a fortification was again built on the city hill in response to the increasing threat from Persian and Arab troops.[197] Nevertheless, Pergamon was finally conquered in

189 Recent overview in Pirson 2017, 96–117 with further reading.

190 Sommerey 2008, 155.

191 Thermal bath 'Ilıca' south of Kane: Pirson 2016, 178–179 (E. Laufer). Thermal bath in the Geyikli Valley: Pirson 2008b, 122 (M. Zimmermann); Pirson 2021a, 261–263 (B. Ludwig – F. Pirson). Allianoi: Müller 2004; Yaraş 2006. Villa maritima on Elaioussa: Hoffmann 1993; Pirson 2016, 180–181 (E. Laufer).

192 Galen, Methodo Medendi 14, 17 f.; Sommerey 2008, 157–158; Pirson – Zimmermann 2014, 151.

193 Galen, Methodo Medendi 5, 49; Müller 2014, 273 (without estimation); Pirson – Zimmermann 2014, 144–145 (estimation of 180,000); Radt 2016, 154 (estimation of 160,000 and 25,000–40,000 for the Hellenistic period); Laabs – Knitter 2021, 2–3 (with translation and different population densities).

194 See appendices A.3, A.4.

195 Marek – Frei 2017, 491–493 and 683–686.

196 Otten 2011; Otten 2014, 173; Otten 2017.

197 Klinkott 2011.

the 8th century CE, destroyed, and barely populated during the following centuries.[198] These threats must have had an impact on the Pergamon Micro-Region as well. The situation of the surrounding countryside in Late Antiquity and the long Byzantine period, however, has hardly been studied so far, and a systematic survey of rural Byzantine settlements does not yet exist.[199]

The settlement structure and its development in the Pergamon Micro-Region were also shaped in particular by agriculture, animal husbandry, and the exploitation of resources.

The abundance of grain and the fertility of the Kaikos Plain (present-day Bakırçay Plain) were emphasized both in the 5th century BCE by the Greek historian Herodotus and in the 1st century BCE by the geographer Strabo.[200] Calculations assume, however, that neither the *chora* nor micro-region could ensure the food supply of the city without imports or environmental modification (e.g., agricultural terracing), at the latest during the Roman Imperial period.[201]

Galen reports beekeeping and the cultivation of lettuce and peas in the 2nd century CE. Furthermore, he mentions the cultivation of wine near Aigai, Pitane, and Perperene.[202]

Archaeological findings, mainly animal bones excavated from cisterns in Pergamon, also suggest livestock breeding in the micro-region.[203]

Forestry to meet Pergamon's requirement for wood is generally assumed to have taken place in the Kozak Mountains, but this has not yet been proven.[204]

However, there is evidence of mining in the region. Strabo mentions an ore mine near Perperene,[205] and there are references to gold mining between Atarneus and Pergamon, where a gold vein near Ovacık is still being exploited today.[206] Quarries must also have been exploited in this area in antiquity. In addition to deposits of white marble in the Kozak Mountains, the quarrying of granite in particular is documented.[207]

Another important resource from the surrounding countryside that Pergamon relied on as it grew in size and population was fresh running water. For this reason, pipelines had led to the city from the northern Madra Dağı Mountains since Hellenistic times. During the reign of Eumenes II in the 2nd century BCE, a high-pressure pipeline was built, which probably supplied the top of the city hill with fresh water for the

198 Radt 2016, 50; Pirson 2017, 119–120.

199 One of the few exceptions for studies on the Byzantine countryside of Pergamon is, e.g., Rheidt 1986.

200 Herodotus 6, 4; Strabo 13, 4, 2; Sommerey 2008, 159; Pirson – Zimmermann 2014, 144.

201 Kobes 1999, 96–98 (*chora*); Laabs – Knitter 2021 (*chora* and micro-region); Sommerey 2008, 161 (on grain imports).

202 Galen 14, 22 f. (beekeeping); Galen 6, 518 (lettuce); Galen 6, 627 (peas); Galen 15, 654, 9–10 and Galen 12, 102 (wine). For a more detailed account of the economic use of the land, see Sommerey 2008, 159–164.

203 Boessneck – van den Driesch 1985; Pirson 2011, 188–199 (M. MacKinnon).

204 Pirson 2008a, 44–45; Radt 2016, 284.

205 Strabo 13, 1, 51; Pirson 2008a, 45 with note 81; Stauber 1996, 290–291.

206 Sommerey 2008, 164.

207 Marble: Conze – Schuchhardt 1899, 148–151; Stauber 1996, 303–304. Granite: Radt 1997; Russell 2013, 86–88, 147.

first time. In the 2nd century CE, additional pipelines were built. An aqueduct pipeline was built from the Madra Dağı Mountains to Pergamon, and another pipeline carried water from the upper Bakırçay Valley to Pergamon.[208] Due to the increased availability of water in the city, the discharge from the city hill had to be regulated as well. The '*Astynomoi* inscription' of Pergamon, a law from the 2nd century BCE that was reestablished in the Lower Agora in the early 2nd century CE, regulates duties for the maintenance of cisterns, canals, and roads.[209]

Information on the paleovegetation in the region was provided by the analysis of a sediment core from Elaia.[210] According to Shumilovskikh et al., the landscape around Elaia was originally characterized by open forests of deciduous oaks and pines before a transformation to a cultivated landscape began around 850 BCE; this lasted until about 800 CE. For this period, increased fire activity as well as an increase in soil erosion could also be attested. A recent study, based on a sediment core from the Kara Göl Crater Lake in the Kara Dağı Mountains, revealed further information on the paleoenvironmental conditions and vegetation history from about 1550 BCE until 1350 CE.[211] In this period, the vegetation in the Kara Dağı Mountains changed from deciduous oak forests to a predominance of pine and strong overgrazing, with phases of increased agriculture and pastoral activities.

208 Most recently Garbrecht 2001; Fahlbusch 2014; Radt 2016, 147–158.

209 Kolbe 1902; most recently, Saba 2012; Vorsanger 2021. See also chapter 5.1.

210 Shumilovskikh et al. 2016.

211 Pirson 2021a, 300–309 (L. Shumilovskikh – M. Seeliger – H. Brückner).

4. Approach, Methods, and Materials

This chapter summarizes the data sets as well as the methods and analyses applied in the three case studies within this thesis (chapter 5). For this purpose, sections from the published manuscripts have been used and partly modified or extended. Prior to this, the general approach of this thesis is briefly outlined.

4.1 General Approach

Applying spatial analyses, the thesis aims to identify and interpret the interdependencies between Pergamon, other urban and rural settlements, and the landscape and to evaluate a possible transformation of the rural settlement structure within the Pergamon Micro-Region in the phase from the Hellenistic to the Roman Imperial period. In order to achieve this, the following approach was elaborated and applied:

(1) The landscape archaeological focus of this thesis requires a conceptual framework that enables the interactions between humans and the natural environment outside the city of Pergamon to be addressed in all their contexts, going beyond the boundaries artificially set by merely geographical or historical-archaeological considerations. For this reason, the category of micro-regions was refined and applied.[212]

(2) In line with the overarching research project (TransPergMikro), the study period of this thesis was set as the phase from the Hellenistic to the Roman Imperial period (3rd century BCE to 3rd century CE). It covers the Attalid rule in Pergamon from the 3rd to the 2nd century BCE, the dynamic phase of political transition in the 2nd to the 1st century BCE, and the Roman Imperial period until the 3rd century CE.[213] For this phase, an extensive urban transformation of the city of Pergamon has already been identified, which must have had an impact on the micro-region.[214] Previous research also provides indications of potential concurrent changes in the landscape and in the settlement structure of the micro-region.[215] However, due to the limited precision in dating the survey sites, the synthesis will address only the Hellenistic and Roman Imperial periods in order to identify developments, changes, or transformations over the course of these six centuries.[216]

(3) The main basis of this thesis consists of archaeological information and landscape data regarding the Pergamon Micro-Region. This information comes from a variety of sources, e.g., survey projects, expeditions, literary sources, and old travelogues and maps from the 19th and 20th centuries, which have different regional and temporal characteristics.[217] In terms of reliability, the archaeological information in particular first had to be evaluated before it was linked to landscape data, such as the EU-DEM or TanDEM-X digital elevation models.[218]

212 See chapter 2.2.

213 For the definition of the chronological framework, see chapter 3.6.

214 Pirson 2017.

215 See chapter 3.6 and Zimmermann et al. 2015; Pirson 2017.

216 For dating of the sites, see chapter 4.2.1.

217 See chapter 4.2.1.

218 See chapter 4.2.2.

(4) A multi-year archaeological survey in the Pergamon Micro-Region by the Pergamon Excavation Project of the Istanbul Department of the German Archaeological Institute (DAI) was carried out with conceptual contributions from the author, with his participation, and under his supervision (field directorship), pursuing two goals: First, it expanded the archaeological data set for further analyses. Second, it served to evaluate the aforementioned data sets and to verify the results of analyses in the field ('ground-truthing'). Methodologically, the fieldwork was based on the survey projects carried out between 2006 and 2017, whereas the documentation methods were further developed and adapted to the current state of the art.[219]

(5) In order to achieve the goals formulated in the introduction, digital spatial analyses were applied in the case studies.[220] They are suitable for formulating and testing landscape archaeological hypotheses and research questions, while providing further-reaching results, helping to develop new interpretations, and serving to rethink previous assumptions about the Pergamon Micro-Region from a new perspective. The applied analyses came from different research fields, in particular also from the geosciences. For example, methods from geomorphometry, the science of quantitative land-surface analysis[221] (Topographic Position Index (TPI) and geomorphons), were used to examine and compare the site locations in relation to the overall topography or to specific points, such as roads, monuments, or resources. The analysis of visibility (viewsheds, cumulative viewsheds, inter-visibility, natural visuality), provided insights into the potential perception of the landscape, and visual characteristics were also considered as one of the factors for the location of ancient places. Movement through space was analyzed using least-cost path (LCP) analyses and by calculating isochrones (lines of equal travel time). Least-cost path analyses offered the possibility of identifying the most probable routes between two known places, making assumptions about modes of traffic and ease of travel. Isochrones were used to make statements about the accessibility of places and the surrounding landscape.

(6) Three case studies represent the core of this thesis, each of which examines different aspects of the Pergamon Micro-Region:

a) Routes are not only a symbol of the close connection between city and countryside but also formed the infrastructural framework of the micro-region in antiquity. They were used to access vital resources, to trade and transport agricultural goods, and they also facilitated communication and military movements. The first step was therefore the initial reconstruction of the route network in Pergamon's surroundings in chapter 5.1.

b) Harbors and landing sites served as the destination and hub of all maritime activities in the west of the micro-region, including economic and military aspects. In chapter 5.2, these places were therefore studied by developing a functional categorization and hierarchy. Taking into account the distinctive topography along the coast, their relations and connectivity with the micro-region and Pergamon were analyzed.

219 On previous survey projects, see note 111. On the applied methodology in the field, see chapter 4.2.1 and appendix A.3.

220 See chapter 4.3.

221 Pike et al. 2009, 3.

c) The urban development and success of the Attalid rule was highly dependent on unrestricted and permanent access to the micro-region, which provided essential resources and important transportation and communication routes. Controlling and securing them must have been a high priority for Pergamene rulers but had been little studied so far. Chapter 5.3 therefore examined Pergamon's ability to monitor and control the micro-region through the placement and use of fortified places and through a surveillance network based on visibility.

(7) Finally, the results of the case studies are synthesized with the aim of creating a portrait of the Pergamon Micro-Region that (a) goes beyond the urban boundaries of Pergamon and individual sites, (b) considers both the importance of humans and the natural environment, and (c) reveals a transformation of the settlement structure within the Pergamon Micro-Region from the Hellenistic to the Roman Imperial period.

4.2 Data Sets

4.2.1 Archaeological Data

This thesis is based on a comprehensive data set of archaeological sites that has been derived from a multitude of different contexts. Information was mainly obtained from archaeological survey projects carried out since 2006 but also from travelogues, early research reports, and maps.[222] Essential data sources included the digital research archive and databases (iDAI.field1 and iDAI.field2) of the Pergamon Excavation Project of the German Archaeological Institute (DAI) as well as publications and digitized maps. All available information was systematically compiled in a digital catalog of archaeological sites within the iDAI.field2 database. In total, 55 sites were included in the analyses of this thesis, with many more forming a comparative basis and interpretive context.

The origin and composition of the archaeological data set is heterogeneous. A disparate and diverse data set also affects the quality and reliability of analyses and studies. Therefore, the archaeological surveys in particular must be critically examined in terms of the quality and reliability of their information.

Archaeological surveys generally provide only limited information on the size and function of the documented sites, as well as on their dating and chronology. This is particularly true when, as in the present case, no subsequent archaeological excavations can be conducted due to legal requirements in Türkiye.

Concerning the archaeological data set used in this thesis, the following two aspects should be considered.[223]

First, the data fuzziness: The different survey projects did not follow standardized criteria in categorizing sites, assigning functions, or using terminologies.[224] This led to different site typologies based on both historical and empirical approaches. Furthermore, a detailed chronology is required for a diachronic analysis. However, the different levels of detail regarding chronological assignment or periodization that were applied by the survey projects are problematic (e.g., Hellenistic versus Early Hellenistic and Late Hellenistic, or Prehistoric versus Epipaleolithic, Neolithic, Bronze Age). Because of these chronological inconsistencies, comparative analyses in this thesis must generally remain at the level of larger temporal categories.

Second, the survey and find collecting strategies: In general, two survey strategies were employed in all projects. The surveys were conducted both a) extensively, i.e., covering a relatively large area, using an unsystematic and judgmental strategy, and documenting at a site-based level and b) intensively, i.e., covering a relatively small area, using a systematic field-walking strategy, and documenting in more detail on an artifact-based level. The latter method in particular, which is usually carried out on-site and

222 See chapter 2.3.

223 Survey strategies and archaeological data sets as well as their inherent problems are covered in a large body of literature and will not be discussed further here. See, e.g., Barker 1991; Bowden et al. 1991; Banning 2002; van Leusen 2002; Witcher 2008; McCoy 2017.

224 C. Schuler has already formulated the development of a regional typology of rural settlements in Asia Minor as a necessary goal of future research (Schuler 1998, 13 with note 29). A functional typology of rural settlements for the Pergamon Micro-Region is currently being developed within the TransPergMikro project.

is intended to provide information on the extent and find statistics, was conducted differently depending on the project and site. Quadrants were defined with side lengths of 1.5 m, 5 m, or 10 m and were either randomly distributed or arranged in a grid.[225] The decision criteria for these different quadrant sizes were, for example, the presumed extent of the site, vegetation cover, and relief, as well as the available time and personnel capacities. Between the survey projects, the practice of collecting finds varied from not collecting any finds at all (due to legal requirements), to collecting only 'diagnostic pottery' (pottery with datable features), or collecting all finds.

To improve and further refine the archaeological information for this thesis, extensive surveys were conducted on the Kane Peninsula and in the northern Yunt Dağı Mountains between 2017 and 2018.[226] The new and important findings were primarily incorporated into the studies of chapters 5.2 and 5.3. This goal was also continued in the large-scale survey project carried out since 2019, which also had the aim of improving survey strategy by incorporating the latest technological developments.[227] To cover a relatively large area, an extensive survey remained the first choice but was complemented by close interaction with local communities. The intensive survey strategy was further developed to the extent that quadrants were no longer required to record site extent or to collect site statistics. Through the use of tablet PCs and appropriate open-source software, it has now become possible to walk sites completely systematically and to document all finds and features in their position and with their characteristics. This strategy allows a more complete picture of sites – or even areas. The level of detail of the statistics is defined only by the distance between the walkers and can be adjusted between a single site and a region. The results of the 2019 and 2020 surveys could subsequently be included mainly in chapters 5.1 and 5.3.[228]

4.2.2 Geodata

Specific aspects of the character and development of the landscape in antiquity have been studied through geo-archaeological fieldwork within the Pergamon Micro-Region since 2008. These results were systematically collected and integrated into the analyses or interpretations at the appropriate point.

Geo-archaeological research has identified environmental changes along the coastline of the Pergamon Micro-Region: the siltation of the harbor basin of Elaia, coastal displacements and sea level fluctuations along the coast, as well as the (probably anthropogenically influenced) siltation of the sound between ancient Kane on the third Arginusae Island and present-day Bademli on the mainland.[229] Further inland, the 'Dörpfeld scenario,' the discussion of whether the original estuary of the Bakırçay River flowed into the sea north of the Kara Dağı Mountains near Atarneus or south of them between Pitane and Elaia,

225 See Pirson 2007, 48; Pirson 2009, 171 (B. Horejs); Pirson 2010, 164–165 (B. Horejs); Zimmermann et al. 2015, 204–205.

226 Appendices A.1, A.2.

227 Appendix A.3.

228 Appendices A.3, A.4.

229 See chapter 5.2 with further reading.

was relevant for the reconstruction of the route network.[230] Current physical-geographic work aims at a general paleoenvironmental reconstruction and the study of geomorphodynamics in the micro-region.[231]

Digital elevation models (DEM) represent the main data set for the analyses carried out. However, they entail a number of pitfalls that must always be taken into account. On the one hand, DEMs are mostly based on satellite data, which represent the present situation and (can) deviate strongly from the ancient one. This can be counteracted to a certain degree by integrating the geo-archaeological studies mentioned above. On the other hand, the quality of the base DEM plays an important role when performing spatial analyses. It has a significant impact on the results obtained and thus on their landscape archaeological interpretation. It is therefore important to disclose and discuss the data sets used, on which the further analyses are based, before deriving any landscape archaeological conclusions.

For the analyses, the EU-DEM v1.1 was available, which is provided open access by the EU Copernicus project.[232] It has a pixel resolution of 25 x 25 m and a vertical accuracy of 7 m (Root Mean Square Error RMSE), and it was used for the calculation of least-cost paths in chapter 5.2. On the one hand, the open-access model guaranteed reproducibility and transparency. On the other hand, it is assumed that the higher the resolution of the digital elevation model is, the more reliable and accurate the results are.[233] For this reason, an application for the scientific use of TanDEM-X data was submitted to the German Aerospace Center (DLR).[234] The data obtained take the form of a digital elevation model from the TanDEM-X satellite mission provided by the German Aerospace Center (DLR) and the European Space Agency (ESA); it has a resolution of 12 × 12 m per pixel and a vertical accuracy of 2 to 4 m, depending on the slope.[235] It served as the basis for analysis in the case studies within this thesis as well.

230 See chapter 5.1 with further reading.

231 See Pirson 2020, 223–227 (F. Becker – D. Knitter – X. Yang – B. Schütt); Becker et al. 2020; Pirson 2021a, 278–287 (F. Becker – X. Yang – M. Nykamp – M. Doğan – B. Schütt); Yang et al. 2021.

232 Copernicus Programme 2022b.

233 See Knitter – Ludwig 2021.

234 Proposal ID: DEM_OTHER1746 (F. Pirson, B. Ludwig).

235 Deutsches Zentrum für Luft- und Raumfahrt (DLR) 2020.

4.3 Spatial Analyses

The legacies of human activities in the landscape, e.g., architectural remains or artifacts, and elements of the natural environment can be localized in space. Accordingly, the processes and phenomena studied in this thesis have a spatial component that can be investigated using digital spatial analysis.

The thesis focuses on three major fields of spatial analyses: visibility analyses, geomorphometric analyses, and the modeling of movement. These analyses address the use of space in the past on an inter-site level, linking the spatial components of archaeological sites to each other and to elements of the natural environment, e.g., relief, sea, or rivers.

In the following, the analyses applied in the thesis are presented and their theoretical and methodological limitations are discussed. The analyses were performed exclusively in the open-source software GRASS GIS, QGIS, and R.[236] The packages, algorithms, and parameters used differ and are mentioned either at the appropriate section of the case study or published alongside the study.

Transparency and reproducibility are the foundation for the reliability of quantitative and computer-based methods and their results.[237] The analyses in chapters 5.1 and 5.2 are transparent since only open-source software was used and the packages, algorithms, and parameters are specified in the relevant sections. The study in chapter 5.3 furthermore qualifies as transparent and reproducible. All data and materials required for the reproduction of this study were published in a data repository alongside the publication.

Long-term preservation and archiving of all newly generated data were ensured through integration into the digital research archives and iDAI.world systems of the German Archaeological Institute (DAI).[238]

4.3.1 Visibility Analysis

Visibility is considered to be a structuring element of past landscapes; it provides insight into potential landscape perception, and visual characteristics can be considered factors in the selection of settlement sites.[239] Seeing and being seen can be associated with a need for protection, religious beliefs, or communication. It has been shown that sites can also be deliberately visually aligned with other places or characteristic natural elements.[240] The study of visibility therefore has numerous applications in landscape archaeological research today.[241]

The analysis of visibilities can refer to the visibility from a particular site (viewshed), the cumulative visibility of several sites (cumulative viewshed), the mutual visibilities between two sites (inter-visibility),

236 GRASS Development Team 2022; QGIS Development Team 2022; R Core Team 2022.

237 Knitter – Ludwig 2021 with further reading.

238 DAI IT-Department 2022.

239 Wheatley – Gillings 2000, 4; Gillings – Wheatley 2001, 26; Wheatley – Gillings 2002, 201–204; Llobera 2001.

240 Wheatley – Gillings 2000, 3; Doneus 2013, 303. For Pergamon, see, e.g., chapter 5.2, 5.3, and Pirson – Ludwig (in press).

241 Brughmans et al. 2018; Fábrega-Álvarez – Parcero-Oubiña 2019; Lewis 2020b among many others. See also Gillings – Wheatley 2020 with a recent overview and further reading.

or the natural visibility of a particular region (natural visibility), all of which are valuable tools for the study and interpretation of the mentioned phenomena.

4.3.1.1 Applications of Visibility Analysis

Viewsheds are the areal extent of visibility from a designated place. In GIS, one can calculate a viewshed based on the surface values of a digital elevation model (DEM). Using given assumptions, such as the location and height of observer and target, earth curvature, or maximum distance, the viewshed function will assign a value of 1 (visible) or 0 (not visible) to each raster cell. The result is a binary map with the values 'visible' and 'not visible.' In GIS analyses, the observer's field of vision is infinite, restricted only by the extent of the applied terrain model or curvature of the earth, although other parameters can be applied, such as observer or target height, visual range, or scope. In practice, however, seeing and recognizing is determined by, e.g., the size of the object, the contrast to its surroundings, or its brightness, color, and shape. To compensate for this, the Higuchi viewshed analysis was introduced to archaeological research, which classifies the range of visibility to distance values.[242] This method was further adapted by integrating environmental (haze, light conditions, etc.) and object-related (size, contrast, etc.) factors into the calculation.[243] In these 'fuzzy' viewsheds, degrees of visibility between 1 (clearly visible) and 0 (not visible) are assigned.

After repeating the calculation of single viewsheds from different observer locations in a study area, a **cumulative viewshed** can then be obtained by combining all viewsheds.[244] In addition to specifying 'visible' or 'non-visible,' the cumulative viewshed indicates the number of observer locations that each raster cell of the DEM is visible from. A cumulative viewshed of all the sites can, for example, give an impression of the entire area that could be visually monitored.

The visibility between two locations can be investigated along a straight line (**line-of-sight**). The position and height of the observer and the target must be defined. Based on a digital elevation model, the visible and hidden sections along the projected line between the observer and the target can then be displayed. If the elevation values of all raster cells of the DEM fall below the line-of-sight, this corresponds to visibility; if one or more elevation values fall above the line-of-sight, the line is interrupted and there is no visibility. Performing this procedure in both directions, the **inter-visibility** between two locations can be calculated.[245]

To gain insights into the relationship between visibility in the landscape and the location of ancient places, the **natural visuality** of a particular region, for example the Pergamon Micro-Region, can be calculated. The term visuality implies the qualitative potential of visibility provided by certain areas and the degree to which studied places were themselves naturally prominent within the landscape, as well as the views that they afforded.[246] It also references the area of visual interaction between those places. To calculate the natural visuality of a given region, randomly distributed points, representing observer

242 Higuchi 1983; Wheatley – Gillings 2000.

243 Ogburn 2006; Llobera 2007.

244 Wheatley 1995.

245 Conolly – Lake 2006, 226; Doneus 2013, 303–304.

246 Llobera et al. 2010.

locations, are first generated. The number of points is determined according to the resolution of the DEM and the required detail level of the result. The viewsheds of all points are then combined into a cumulative viewshed representing the natural visuality of the region. This is an adapted variant of the total viewshed.[247] In this process, viewsheds are calculated and combined for each raster cell of the DEM.

4.3.1.2 Critical Discussion of Visibility Analysis

The early introduction of GIS-based visibility analysis into landscape-based archaeological research in the 1990s and its longstanding application have since led to an examination of the theoretical underpinnings of visibility and a detailed discussion of methodological and theoretical limitations, which are summarized below.[248]

One of the most frequently mentioned points of criticism is the fact that visibility analyses are carried out on the basis of present-day terrain models; the paleoenvironment is mostly disregarded. Paleovegetation and its seasonal changes also have an effect on visibility but can only be reconstructed to a certain extent.[249] The contrast of the target to its surroundings, its brightness, color, and shape are crucial for visibility in terms of object-environment contrast.

Most visibility analyses are based on static calculations from one starting point to one or more other points. Since the observer normally travels through the landscape, however, visibility maps would have to be created along a predefined path and then combined.[250] Furthermore, a mutual visibility between observer and target is often assumed, but this is not necessarily correct.[251] This is particularly relevant for the investigation of inter-visibility between two or more places and means that visibility must be calculated in each direction.

Numerous older criticisms relate to the production of visibility maps and can be (partially) invalidatedby today's technological advancements.[252] Visibility analyses are usually based on a digital elevation model (DEM), the graded elevation values, accuracy, and resolution of which have been criticized in the past.[253] The quality of the models, however, is steadily increasing and reaches resolutions of meters to a few centimeters (e.g., light detection and ranging data (LIDAR)) today. With the highest possible resolution grid and fine gradations of elevation, deviations are less of a problem today.[254] Furthermore, the quality of the DEM does not necessarily correspond to that of the result: Peaks or spurs in the terrain have a greater influence on the calculation of visibilities than plains. Furthermore, deviations in relief near the observer point have a greater effect on the result than similar deviations at a greater distance.[255] To address this

247 Llobera 2003.

248 Van Leusen 1999; Gillings – Wheatley 2001; Conolly – Lake 2006, 228–233; Gillings – Wheatley 2020. For a comprehensive overview, see Wheatley – Gillings 2000, 5–14.

249 Wheatley – Gillings 2000, 5–7.

250 See chapter 5.2 for examples.

251 Wheatley – Gillings 2000, 7–8 with notes 17, 19, 39.

252 See also Higuchi and 'fuzzy' viewsheds above.

253 Wheatley – Gillings 2000, 9–10.

254 Posluschny 2008, 368.

255 Gillings – Wheatley 2001, 31.

issue, in chapter 5.3, for example, the most exposed point of each site was defined as the observer point based on the TPI values within a 100 m radius.

The applied algorithms and parameters are also much more transparent and comprehensible today thanks to open-source software or the parallel publication of metadata.[256] Other criticisms include the robustness and sensitivity of the analyses in relation to changing observer or target heights.[257] In chapter 5.3, the uncertainty regarding the observer height (in this case, the height of the original fortifications or towers) was addressed by repeating the analyses with different heights. Especially with multiple or cumulative viewsheds, there is a risk of edge effects, i.e., if places outside the study area are not included in the calculation.[258] By incorporating a sufficiently large buffer around the actual area of interest, this problem can be avoided.

Further criticisms address the interpretation of the results of visibility analyses. These are said to be eco-deterministic since they refer exclusively to the relief.[259] They are also subject to technical determinism and are more the result of methodological-technical possibilities than archaeological theory.[260] Another problem is the apparent separation and preference of vision over the other senses, i.e., a kind of hierarchization.[261] On the one hand, visibility should therefore never be considered on its own; on the other, integrating sounds or smells into analyses is exceptionally difficult because they are extremely variable and can change within a very short time.[262] Further criticism is made of the two-dimensional map representation or the map perspective. The three-dimensional field of view is too complex to reduce it to a two-dimensional plane and to interpret it from a superordinate perspective from above.[263]

These criticisms may point out weaknesses, and there is no doubt that GIS-based analyses do not produce any 'truth.' But if the interpretive authority remains with the researcher and they take the aforementioned shortcomings into account, for example, by supplementing the analyses with their own experiences in the field ('ground-truthing'), then visibility analyses can be valuable tools for the investigation and interpretation of past visual perception and human spatial behavior.

4.3.2 Geomorphometric Analyses

Relief plays an important role in the analyses applied in this thesis. Its characteristics strongly determine soil conditions, water availability, and vegetation characteristics, and its present form is the basis for understanding past geomorphodynamics.[264] Spatial aspects of past human behavior can partly be attributed to relief as it has an influence on the physical-real and perceived distance between two places.[265]

256 For examples related to Pergamon, see chapter 5.3 and Knitter – Ludwig 2021.
257 Wheatley – Gillings 2000, 11.
258 Van Leusen 1999, 218–219.
259 Doneus 2013, 305–306.
260 Wansleeben – Verhart 1997; Wheatley – Gillings 2000, 12.
261 Wheatley – Gillings 2000, 13.
262 Doneus 2013, 306.
263 Wheatley – Gillings 2000, 13.
264 Yang et al. 2021.
265 Doneus 2013, 104; Huggett 2016; Yang et al. 2021.

In addition, the relative location of archaeological sites and their characteristics, such as visibility or accessibility, are strongly linked to the surrounding local topography. An exposed or elevated position within the landscape can increase the possibility of observing the environment or communicating over greater distances. To ensure good accessibility, on the other hand, a less exposed or elevated position may be of primary importance. To derive more information on the environmental characteristics of the archaeological sites, two methods from geomorphometry, the science of quantitative land-surface analysis,[266] were applied in this thesis: Topographic Position Index (TPI) and geomorphons.

4.3.2.1 Applications of Geomorphometric Analysis

The **Topographic Position Index (TPI)** is a measure of the difference between the elevation of a point on a DEM and the mean elevation of the neighboring cells within a predetermined radius.[267] In this thesis, the point usually represents the location of a site, and the neighboring cells represent the relief. Sites with positive TPI values are located higher than the average of their surrounding landscape, and sites with negative TPI values are located lower, meaning that positive TPI values indicate an exposed location within a landscape while negative TPI values indicate a valley or depression-like location. TPI values around zero correspond to flat areas or constant slopes. Using this method, the topographic positions of the sites relative to the local relief can be classified.

The other geomorphometric concept employed in this thesis is that of **geomorphons**, which are terrain form classes derived from a DEM that help differentiate topography.[268] The classes are divided into the following ten landform types: flat, summit, ridge, shoulder, spur, slope, hollow, foot slope, valley, and depression. This concept was introduced by Tomasz F. Stepinski and Jaroslaw Jasiewicz, who define a geomorphon as "a relief-invariant, orientation-invariant, and size-flexible abstracted elementary unit of terrain."[269] Thus, geomorphons are much less sensitive to scale. Instead of a fixed neighborhood size, e.g., a specific number of immediate neighboring cells of a DEM, this method uses pixels determined from the line-of-sight principle along the eight compass directions. The search radius represents the maximum allowable distance for the calculation of their zenith and nadir angles. All pairs of zenith and nadir angles are converted into a pattern and assigned to a geomorphon.[270]

4.3.2.2 Critical Discussion of Geomorphometric Analyses

The application of geomorphometric analyses in landscape archaeological contexts leads to similar discussions and criticisms as the use of visibility analyses. The comparison of site locations with various environmental features is generally susceptible to being both static and not taking into account the temporal dimension of human behavior, as well as favoring environmentally deterministic explanations for settlement patterns.[271] While the first criticism is more a problem of the data basis than of the method, the second point requires attention in the application of the analyses and the interpretation of their

266 Pike et al. 2009, 3.

267 Weiss 2001; Lindsay et al. 2015.

268 Stepinski – Jasiewicz 2011; Jasiewicz – Stepinski 2013.

269 Stepinski – Jasiewicz 2011, 109.

270 Jasiewicz – Stepinski 2013, 152.

271 Verhagen 2018, 14 with further reading.

results. They can then be a versatile tool to explore location preferences, identify and compare patterns, and assess variations in a diachronic perspective.[272] Analyses gain additional significance when combined with other methods and interpreted in the context of geomorphodynamic and archaeological-historical information.

4.3.3 Modeling Movement

Movement through the landscape in the past created routes that connected cities and rural settlements, as well as resources, farmland, burial grounds, or sanctuaries at local, regional, and supra-regional levels. The routes primarily enabled movement, transportation, and communication between these places. Their course was influenced by environmental factors (e.g., topography, water bodies, soil conditions, or vegetation) as well as sociocultural factors (e.g., land tenure or the perception and attraction of landscape features or monuments). The effort to reach a specific location in the landscape can thus be different from two places that have the same distance to the destination. In order to explain the spatial distribution of sites in the Pergamon Micro-Region, the potential of and constraints on movement through the landscape first have to be understood.

There are several approaches to studying movement in the past through computational modeling. One aspect is the modeling of movement along routes between two locations or in a network. These routes, however, rarely emerge at a single event but rather through long-term and repeated use and experimentation by many individuals, whereby a route accumulates cumulative 'knowledge' over time.[273] This past knowledge can be approached through the calculation of least-cost paths. They offer the option of calculating areas or pathways in the landscape that are 'most favorable' (measured, e.g., in time or effort), taking into account predefined parameters (e.g., environmental characteristics, speed, visibility). Another aspect is the modeling of movement through an area instead of along a route, for example around a settlement. Isochrones, lines of equal travel time, can be calculated and mapped from a defined location, indicating an area that can be reached in a given timeframe.

Despite the numerous factors influencing movement in the past, even simple modeling based on relief, i.e., generally slope, can serve as a tool for reconstructing potential routes, discussing existing or assumed routes, and developing new hypotheses and interpretations. It also allows the investigation of different scenarios and their comparison with the archaeological record by repeatedly changing the values and weights of parameters.[274]

4.3.3.1 Applications of Modeling Movement

Where the available archaeological and historical data on ancient roads and their courses are insufficient or the data are unavailable, modern computer-aided analyses can be of assistance. **Least-cost path (LCP)** analyses offer the possibility of identifying the most probable routes between two or more known locations, making assumptions about modes of traffic and ease of travel, or of identifying the factors governing the construction of already known routes. With the introduction of GIS to landscape archaeological

272 Verhagen 2018, 14.

273 Doneus 2013, 319.

274 Polla – Verhagen 2014, 1.

research, the calculation of least-cost paths became increasingly popular.[275] Their calculation in landscape archaeological studies is based predominantly on raster grids, e.g., digital elevation models (DEMs) or land cover raster maps. On this basis, cost surfaces are created in a first step that models the 'cost' of movement, usually measured in time or energy expenditure. Since relief is an obvious influencing factor when moving through the landscape, slope is often used as a cost component. These costs are usually calculated based on Tobler's hiking equation.[276] As described above, movement through the landscape is influenced by numerous factors. Thus, land cover, soil properties, hydrological data (as a barrier or transportation route), existing routes, or visibility can also be integrated into the calculation as cost components. However, numerous factors such as territorial demands, seasonal restrictions, different modes of transportation (e.g., walking, horseback, boat), and different modes of travel (e.g., different numbers or types of travelers) can usually only be taken into account to a limited extent.[277] In a second step, the different factors can be combined into an accumulated cost surface (ACS), taking into account their weighting.[278] The ACS is then used to calculate the 'least-cost' path between two locations using an LCP algorithm, most commonly Dijkstra's algorithm.[279] Due to the high variability of LCP algorithms, cost components and functions, and their appropriate combination, there is no standard procedure for calculating least-cost paths.[280] Nevertheless, the application of the analysis and the selection of parameters encourage an intensive study of movement through the landscape in antiquity. It can thereby provide new insights into the infrastructure and spatial organization of the ancient landscape in terms of trade, transportation, security, or the connection of different places.[281]

The accumulated cost surfaces (ACS) described in the previous section, however, can also be used to analyze the size, location, and environmental characteristics of site territories.[282] In this thesis, they were used to find the area around a site that could be reached within a given time. This area was then mapped as **isochrones (lines of equal travel time)**.[283] They show the anisotropic cumulative time of moving from a defined location, comparable to least-cost paths without a defined target. To help interpretation, the isochrones were divided into 1-hour intervals over a range of up to ten hours. In the calculation, the same factors affecting movement apply as for least-cost paths, which can be included in the accumulated cost surface (see above).

Isochrones allow the study of movement through the landscape to move from paths and routes to area-based observations and hypotheses. Thus, in chapter 5.3, they were used to estimate travel times from fortifications through their immediate surroundings, that is, the extent to which travel times were a factor influencing strategic movements.

275 Verhagen – Jeneson 2012; White – Surface-Evans 2012; Herzog 2014a; Güimil-Fariña – Parcero-Oubiña 2015; Herzog – Schröer 2019; Lewis 2021 among many others.

276 Tobler 1993; Herzog 2020; chapter 5.1.

277 Bevan 2013, 5.

278 Herzog 2014b.

279 Dijkstra 1959; Cormen et al. 2009, 658–664.

280 Herzog 2014b.

281 Bevan 2013; Herzog – Posluschny 2011.

282 Verhagen 2018, 16.

283 See Becker et al. 2017; Oltean – Fonte 2021.

4.3.3.2 Critical Discussion of Modeling Movement

Both methods, least-cost paths and isochrones, are generally based on (accumulated) cost surfaces, as previously described. The definition of the individual cost components as well as their combination and weighting thus have the greatest influence on the modeling of past movement.[284] In the presented case studies (chapters 5.1–5.3), environmental factors, especially the effect of the slope on the movement, are taken into account. The slope information was previously derived from a digital terrain model whose level of detail and accuracy subsequently also determine the level of detail of the result. Digital elevation models generally represent today's topography. Potential environmental changes since antiquity, or even just seasonal changes, can usually only be integrated into the calculation to a certain extent and must be taken into account at the latest when interpreting the results. This also applies to other cost components, such as vegetation cover, water bodies, or soil properties, which may have changed since antiquity.[285]

In addition to the environmental factors mentioned above, social or cultural factors also had an impact on movement in the past. It is not so much their consideration that is problematic as the sheer number and variety of factors influencing movement in the past.[286] Land tenure or taboo areas can also be modeled theoretically, but there is usually a lack of information available to do so. Other factors are easier to quantify and include: different modes of travel (e.g., different numbers or types of travelers), different types of travel (e.g., walking, horseback, or oxcart) or different loads (e.g., people, wood, or stone).[287] Elements of a landscape can also affect movement on a mental level.[288] For example, visibility or orientation to landmarks are often integrated into the modeling of movement using visibility analyses.[289]

The knowledge and intention of the traveler is more challenging to model. Pre-existing routes or particularly well-developed routes with road surfaces and bridges may have been attractive.[290] A traveler would also have used their knowledge of the benefits of moving to intermediate destinations or a particular place for the choice of route.[291]

This brief outline reflects the advanced and ongoing discussion of the theoretical and methodological limitations of modeling movement in landscape archaeological contexts. At the same time, the myriad ways and means of modeling enable the development and testing of hypotheses about how and where people moved through the landscape in the past and what factors influenced their movement.[292]

284 Herzog 2013; Verhagen 2018.

285 Herzog 2014b.

286 For detailed accounts on theoretical, methodological, and technical limitations in the modeling of movement, see Herzog 2014b; Herzog 2020; Herzog 2021.

287 Bevan 2013.

288 Llobera 2000, 72.

289 See, e.g., Bell – Lock 2000; Zakšek et al. 2008; Lock et al. 2014; Wernke et al. 2017.

290 Herzog 2014b; Llobera 2020.

291 Polla – Verhagen 2014, 1.

292 Verhagen 2018, 17.

5. Landscape Archaeological Case Studies in the Pergamon Micro-Region

5.1 Reconstructing the Ancient Route Network in Pergamon's Surroundings

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Abstract

The surrounding landscape of ancient Pergamon is characterized by several mountain ranges: the Bakırçay Valley and River and the Aegean coastline. The accessibility of this region was vital for the city since it provided food and resources as well as trade, communication and military movements, all facilitated by a well-developed route network. Despite the importance of roads for the development and prosperity of the city, the ancient route network is still widely unexplored and archeological evidence of roads is extremely rare. This study therefore aims to reconstruct the ancient route network in the surroundings of Pergamon by combining historical and archeological sources with modern computer-aided least-cost path analyses, while also considering changes in the landscape that have occurred since antiquity. Based on these detailed results, conclusions may be drawn about the characteristics and functional diversity of the routes. Although the investigation of the route network in the surroundings of Pergamon cannot be considered complete, the results of this study already offer a valuable basis for further research, analyses, modeling and field work.

Keywords: ancient roads; ancient route network; Bakırçay Valley; GIS; itineraries; landscape archeology; least-cost path analysis; milestones; Pergamon; Western Asia Minor

1. Introduction

The ancient city of Pergamon (modern Bergama) is located about 25 km inland on a steep hill in the lower Bakırçay Valley (Kaikos Valley). Although it was one of the most important urban centers in Asia Minor, the city had no direct access to the sea. It is generally assumed that this situation placed the city at an economic disadvantage compared to coastal cities such as Ephesus and Smyrna.

To counterbalance this supposed disadvantage, the coastal settlement of Elaia, which had existed since archaic times, was developed into the harbor city of Pergamon under Attalid rule.[293] In addition to the most important harbor of Elaia, that sheltered the Pergamenian fleet, other harbors such as Pitane (modern Çandarlı) or Kane (modern Bademli), provided supra-regional trade, transport and communication. The fertile Bakırçay Plain was an essential agricultural basis for the food supply of the city. Extra-urban sanctuaries, such as Kapıkaya or Mamurt Kale, situated in the Kozak Mountains (Pindasos) and the Yund Dağı Mountains (Aspordenon), respectively, played a significant role in the religious life of ancient Pergamon. Beyond this religious aspect, the mountains provided fundamental resources such as firewood, timber, granite, and marble.

The substantial importance of a route network for Pergamon and its surroundings should therefore already be clear, as it enabled the exchange of people, goods, ideas and information.

Despite the long history of research at this site, the traces of ancient roads in the vicinity of Pergamon are still unknown or only published in fragmentary form.[294] Archeological evidence of roads in this region is also extremely rare. This study therefore aims to narrow this lack of knowledge and open up new perspectives for future research and targeted field surveys in the surrounding landscape of this major urban center.

2. Study Area

The study area extends from the headwaters of the Bakırçay River to the east of the Gölcük Mountains (957 m a.s.l.) to the Kara Dağı Mountains (Kane Peninsula; 754 m a.s.l.) on the Aegean coast (Figure 5.1.1). On its approximately 130 km long course from the springs to the estuary, the Bakırçay River runs through the eponymous valley, which is delimited by the Kozak and Madra Dağı Mountains (Pindasos, 1,243 m a.s.l.) in the north and by the Yund Dağı Mountains (Aspordenon, 782 m a.s.l.) in the south.

The Bakırçay Valley can be divided into three regions. The upper Bakırçay Valley stretches from Kalamos (modern Gelembe) to Kırkağaç and is separated by a ridge of hills south of Stratonicaea/Hadrianopolis into smaller eastern and larger western sections. Further on its course, the Bakırçay River runs through the narrow middle Bakırçay Valley, stretching approximately 20 km. Germe (modern Soma) is located in the center of this subregion. From ancient Apollonia, the valley extends for about 50 km to the Gulf of Çandarlı where the Bakırçay River flows into the Aegean Sea. The coastline north of the estuary is characterized by a steep coast with striking cliffs and a multitude of smaller peninsulas and bays and is dominated by the 750 m high Kara Dağı Mountains, the highest mountains of the Kane Peninsula. The lower Bakırçay Valley is divided into an eastern basin with a maximum width of about 15 km and a

293 Pirson 2014; Pirson et al. 2015.

294 Cf. Pirson 2008a; Külzer 2016; Tozan 2017.

narrower western basin. The center of the lower Bakırçay Valley is marked by the city hill of Pergamon (Figures 5.1.1 and 5.1.2).

On its way from the headwaters north of Kalamos to its estuary in the Gulf of Çandarlı, the main river is fed by numerous tributaries from the neighboring mountains. The city hill of Pergamon, for example, is surrounded by two tributaries of the Bakırçay River. The Kestel Creek (Ketios), which today is dammed to create a reservoir, passes the ancient city hill on its east side, whereas the Bergama Creek (Selinos) flows along its west side.

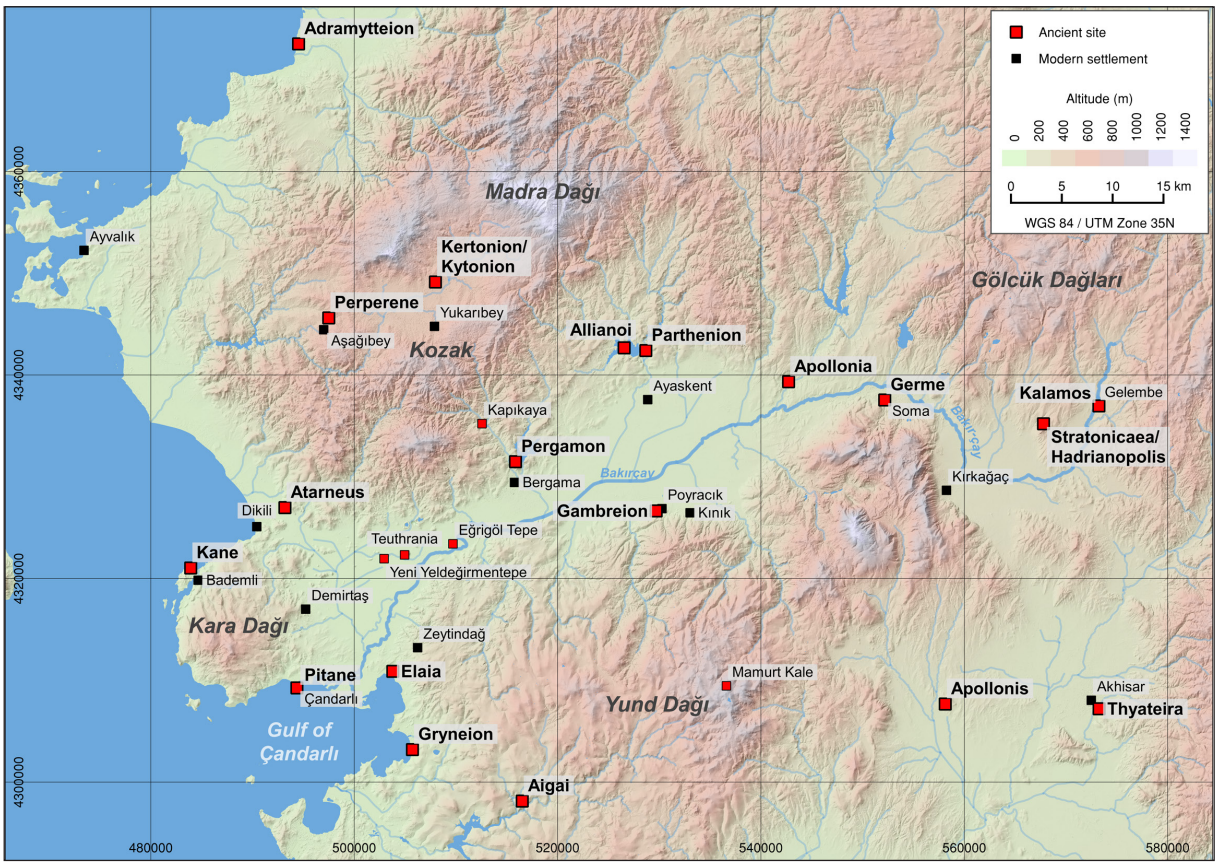

Fig. 5.1.1 Study area with ancient sites.

Fig. 5.1.2 Western lower Bakırçay Valley. View from Kalarga Tepe (Teuthrania) to the east. Background: the city hill of Pergamon, the Kozak Mountains (left) and the Yund Dağı Mountains (right).

The entire plain of the lower Bakırçay Valley was significantly affected by fluvial erosion and deposits of the river.[295] In the area around the Yeni Yeldeğirmentepe, approximately 3.5 m of sediment have been deposited since the Bronze Age.[296] In the area 1.5 km east of Kalarga Tepe (Teuthrania) (Figure 5.1.2), geo-archeological research was able to prove that the terrain was 1.7–2.0 m lower in antiquity than today.[297] Near Atarneus and the Geyikli Valley, the sedimentation in the past 1950 years is at least 6 m.[298] After the Bakırçay River was regulated and dammed up in the last century, the landscape changes caused by the river are now only minimal. Larger changes result from the intensive agricultural use of the plain in recent years.

In the western lower Bakırçay Valley, the river has almost remained in its same course and flows into the sea between Elaia and Pitane. Wilhelm Dörpfeld hypothesized that the estuary of the Bakırçay River was located near Atarneus in antiquity and that the alluvial fan of the Geyikli Deresi or Asarboğaz Çayı blocked this estuary.[299] This created a depression that was already marshy in ancient times and that flooded at certain times of the year until the 19th century.[300] The swamp area is reported to have reached all the way to Kalarga Tepe (Teuthrania).[301] Other researchers contradicted this hypothesis at an early stage[302], and recent geo-archeological research[303] was finally able to disprove it. Today the area has largely been drained by means of channels.

3. Objectives

This study aims to reconstruct the ancient route network in the region of Pergamon by combining historical and archeological sources with modern computer-aided least-cost path analyses, while considering the above-mentioned changes in the landscape. Subsequently, conclusions may be drawn about the characteristics and functional diversity of the routes.

Dating is one of the greatest challenges in the study of ancient roads. Some routes can have a very long usage history, which can hardly be defined precisely. This study, however, aims to focus on routes of the Hellenistic and Roman Imperial period.

4. Methods

To reconstruct the ancient route network, various historical sources and archeological records were first compiled and evaluated. Using this information, an initial outline of the route network can be developed. Probable traces of the routes, however, remain either vague or unknown and for many connections there are no indications at all in the historical sources.

295 Schneider et al. 2015.
296 Pirson 2010, 183–188 (S. Schneider – W. Bebermeier – B. Schütt).
297 Schneider et al. 2015.
298 Schneider et al. 2013; Schneider et al. 2014.
299 Cf. Dörpfeld 1910, 395–399; Dörpfeld 1912, 273–276.
300 Lolling 1879, 7–9; Diest 1889, 8.
301 Lolling 1879, 9.
302 Cf. Philippson 1911; Bittel 1950.
303 Schneider et al. 2013; Schneider et al. 2014.

These gaps were then filled by the calculation of least-cost paths. The reconstructed routes were also based on contemporary paths and trails in the landscape that consider the local topography.

By combining all available sources with modern computer-aided analysis, a comprehensive overview of the ancient route network in the surroundings of Pergamon was obtained.

4.1. Archeological Data

4.1.1. Archeological Remains of Ancient Roads

Only well-documented archeological records of road infrastructure provide a reliable basis for study. The sole proven remains in the area around Pergamon were found during field surveys on the Kane Peninsula.[304] From Kane up into the Kara Dağı Mountains, a paved road leads to the tower houses of Asarlık Tepe and Söğütlü Kale.[305]

Furthermore, short road segments were documented during field surveys on the periphery of Elaia.[306] A road paved with pebbles leads from the north-western gate of Elaia through the necropolis to the Bozyer Tepe. A second road also runs from this city gate northeast to the ancient main road towards Pergamon.

4.1.2. Archeological Remains of Ancient Bridges

When building roads, streams, rivers or swamps must be crossed. Where fords are no longer sufficient, bridges are required to pass these obstacles, and are therefore integral parts of roads networks. In total, 17 at-least-partially ancient bridges can be identified in Pergamon's vicinity (Figure 5.1.3).

The remains of a Roman bridge (bridge 1) are located between Elaia and Pitane.[307] The bridge crossed the Bakırçay River in a southeast-northwest orientation and had three *opus caementitium* piers with ashlars placed in front of them.

Another ancient bridge (bridge 2), which probably also dates from the Roman Imperial period, crossed the Bakırçay River south of Eğrigöl Tepe.[308] Today, only the remains of the bridge heads exist. The bridge was erroneously called Izmir Köprü by C. Schuchhardt, but the actual Izmir Köprü (modern Vakıf Köprü; bridge 3) crossed the river 3.5 km northeast of Eğrigöl Tepe oriented southwest-northeast.[309] From this bridge, an approximately 2 km long and straight road led to Pergamon, which Walther von Diest dated to the Roman Imperial period, like the bridge itself, because of its substructure and straight course.[310]

In addition to the three bridges crossing the Bakırçay River, there is another bridge (bridge 4) over the Asarboğaz Çayı in the western lower Bakırçay Valley.[311] The two-arched Hacıismail Köprüsü (Figure

304 Pirson 2016, 184–185 (E. Laufer); Pirson 2018, 151 (S. Feuser – E. Laufer).

305 Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 211–213 (M. Zimmermann).

306 Feuser (in press).

307 Cf. Diest 1889, 30–31; Philippson 1910, 96; Conze 1912, 114 with supplementary sheet 1 (C. Schuchhardt); Pirson 2010, 197; Tozan 2017, 553; Feuser (in press).

308 Cf. Diest 1889, 30; Philippson 1910, 78; Pirson 2012b, 215 (M. Zimmermann); Pirson 2020, 205–223 (B. Ludwig – Z. M. Aksan – F. Pirson).

309 Conze 1912, 116–117 (C. Schuchhardt).

310 Diest 1889, 29–30.

311 Pirson 2019, 124–125 (B. Ludwig).

5.1.4) lies 5.7 km southeast of Demirtaş in an east-west orientation across the river. This bridge has been renovated and repaired several times in the past, but it is assumed that the substructure goes back to an ancient predecessor.

At the sanctuary of Kapıkaya in the Kozak Mountains, the Bergama Creek (Selinos) was crossable using a Roman bridge (bridge 5) made of *opus caementitium*.[312]

A total of 4.5 km east of Pergamon, parallel to the present-day highway, the Ottoman Koyun Köprü (bridge 6) runs east-west over an abandoned meander of the Bakırçay River.[313]

At Parthenion, a Roman bridge (bridge 7) led to the baths of Allianoi. The bridge lies in a reservoir today.[314]

Furthermore, W. von Diest describes a Byzantine bridge (bridge 8), which crosses the Bakırçay River on the route between Gambreion (modern Poyracık) and Parthenion.[315] This could be Hanum Köprü, which is marked on several maps.[316] W. von Diest also mentions two presumably ancient bridges (bridge 9, 10) over the Karadere Creek southeast of Kınık.[317]

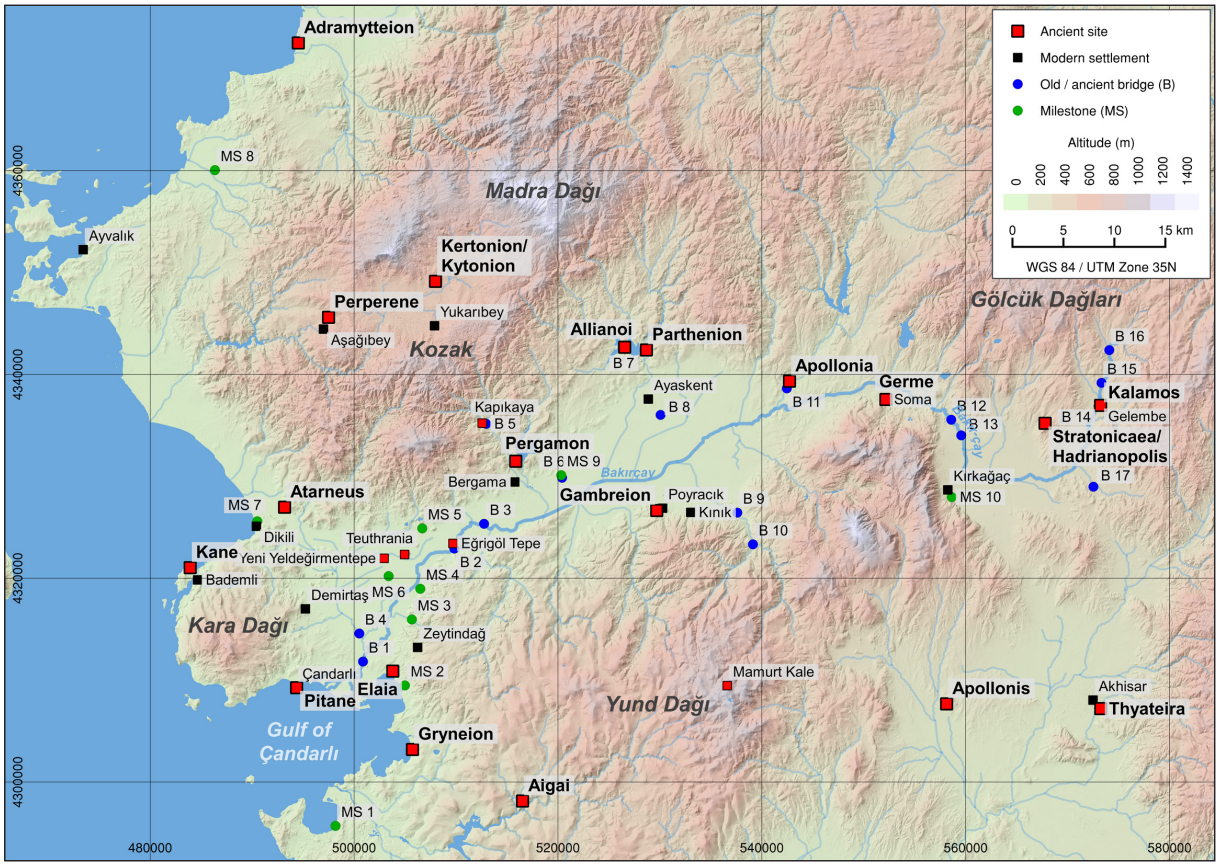

Fig. 5.1.3 Study area with the location of bridges and milestones mentioned in the text.

312 Diest 1889, 9.

313 Diest 1889, 15; Conze 1912, 109 (C. Schuchhardt); Tozan 2017, 538–539.

314 Diest 1889, 13; Conze 1912, 131–132 (C. Schuchhardt).

315 Diest 1889, 15.

316 Conze 1912, 35–42 (O. Berlet).

317 Diest 1889, 15.

Fig. 5.1.4 Hacıismail Köprüsü (bridge 4) in the western lower Bakırçay Valley.

At Apollonia, at the transition between the middle and lower Bakırçay Valley, a medieval bridge with 15 pillars (bridge 11) crossed the river.[318]

Two bridges, Kılıç Köprü (bridge 12) and Ördek Köprü (bridge 13), crossed the Bakırçay River north of Kırkağaç and are dated to the post-Byzantine era by Klaus Rheidt.[319]

Important ancient bridges are located in the upper Bakırçay Valley near Kalamos (modern Gelembe), at the presumed intersection of the ancient roads from Pergamon to Thyateira (modern Akhisar) and from Hadrianoutherai (modern Balıkesir) to Thyateira. K. Rheidt compares the bridge at the western end of Kalamos (bridge 14) with other bridges of the Roman Imperial period.[320]

Two other ancient bridges (bridge 15, 16) are described by W. von Diest north of Kalamos along the ancient road to Hadrianoutherai.[321]

Bridge 17 is located on the route from Kalamos to Thyateira, about 2 km southeast of Karakurt, parallel to the present-day road.[322]

4.2. Additional Sources and Data

One of the most important bodies of evidence in the study of ancient roads and paths are itineraries, such as the *Itinerarium Antonini*, which is a register of roads and waystations from the 3rd century CE. It contains more than 2,000 locations along with distances from station to station. The linear recording of space by means of route plans provided knowledge of connections between individual places and was of great importance for travelers in antiquity, even if the distance figures handed down should be questioned critically today.[323] There is one route in the *Itinerarium Antonini* leading through the study area and across Pergamon (Table 5.1.1).[324]

318 Diest 1889, 16; Conze 1912, 109 (C. Schuchhardt); Conze 1913b, 406 (F. Gräber); Tozan 2017, 538.

319 Diest 1889, 18; Rheidt 1986, 233.

320 Rheidt 1986, 233.

321 Diest 1889, 20.

322 Rheidt 1986, 232.

323 Cf. Miller 1916; critically Kubitschek 1917; or Löhberg 2006; critically Rathmann 2008.

324 Cuntz 2012.

Table 5.1.1 Route through the study area mentioned in the *Itinerarium Antonini*.

Place	Dist.[1]	Place	Dist.	Place	Dist.	Place
Adramitio[2]	53	Pergamo[3]	25	Germe	33	Thyatira[4]

[1] Distance figure in miles. [2] Adramytteion. [3] Pergamon. [4] Thyateira.

Compared to the *Itinerarium Antonini,* the *Tabula Peutingeriana* is a cartographic representation of the road network in antiquity (Figure 5.1.5).[325] The map, whose origin and authors are unknown, was first published in the 16th century by Markus Welser, a distant relative of Konrad Peutinger after whom the map is named.[326] It is assumed that the original map dates back to Roman times[327], although recently hypotheses have been formulated that it has Hellenistic origins.[328] A total of five routes relevant to this study can be identified on the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5). During the process of copying over the centuries, changes and errors appeared on the map.[329] Especially the distance figures can be mis-copied easily and should be questioned critically.

Further information on stations or distances in the study area are provided by ancient milestones, which were summarized by David French (Table 5.1.3, Figure 5.1.3).[330]

Important information on roads and paths in the Pergamene region is also provided by literary sources from antiquity (e.g., Aelius Aristides, Galen, Strabo), most recently compiled by Murat Tozan.[331]

Fig. 5.1.5 Section of segment IX of the *Tabula Peutingeriana*.[332]

325 Miller 1916; Weber 1976; Talbert et al. 2010.
326 Rathmann 2015, 338–339.
327 Talbert et al. 2010, 149.
328 Rathmann 2015.
329 Rathmann 2018.
330 French 2014.
331 Tozan 2017.
332 After Miller 1962.

Table 5.1.2 Routes mapped in the *Tabula Peutingeriana*.

Place	Dist.[1]	Place	Dist.	Place	Dist.	Place	Dist.	Place
[?]tto[2]	none	Pergamo[3]	25	Gerame[4]	33	Tyatira[5]		
[?]tto[2]	15	Corifano	5	Elatia	15	Attalia	10	Ela[6]
Cyzico[7]	none	Phemenio	30	Argesis[8]	35	Pergamo[3]		
Hadrianuteba[9]	8	Pergamo[3]						
Ela[6]	16	Pergamo[3]						

[1] Distance figure in miles. [2] Adramitio (Adramytteion). [3] Pergamon. [4] Germe. [5] Thyateira. [6] Elaia.
[7] Cyzicus. [8] Ergasteria. [9] Hadrianoutherai.

Table 5.1.3 Milestones found in the surroundings of Pergamon.

No.	Description[1]	Reference
MS1	Aliağa	French 2014, 62
MS2	Kazıkbağları 1–6	French 2014, 62–67
MS3	Dereiçi (former Tekkedere)	French 2014, 67
MS4	Kurfallı 1–2	French 2014, 67–69
MS5	Ovacık (former Kalarga)	French 2014, 69
MS6	Aşağı Kırıklar	French 2014, 69–71
MS7	Dikili	French 2014, 71
MS8	Armutova 1–2	French 2014, 71–72
MS9	Bergama, Paşaoğlu Çiftlik	French 2014, 102–103
MS10	Kırkağaç 1–2	French 2014, 181–182

[1] Description after D. French 2014.

A special inscription that offers specific information about the streets in Pergamon is the '*astynomoi* inscription'. Among other things, the width of the lanes of the country roads (*leophoroi*) within the urban territory is regulated by law: "Among the roads that run through the countryside, the main suburban roads (*leophoroi*) shall not be less than 20 cubits in width, the other streets not less than eight cubits, unless some use pathways as access to one another through the [different] areas."[333]

In addition, early travel reports from the 19th and 20th centuries provide important information on the location and course of ancient roads, but also on the design and preservation status of roads and bridges.[334] The reports and maps of the first researchers in Pergamon are worth mentioning.[335] A first

333 Saba 2012, 27–28.

334 Choiseul-Gouffier 1842.

335 Diest 1889; Kiepert 1890; Philippson 1910.

systematic collection of the archeological records in the vicinity of Pergamon was summarized by Carl Schuchhardt[336] and published in combination with a map by Otto Berlet[337].

Atlases such as the Barrington Atlas of the Greek and Roman World[338] or the Historical Atlas of the Ancient World[339] also offer a good overview, but due to their scale, they only show very idealized road courses.

4.3. Least-Cost Path Analysis

Where the available archeological and historical data on ancient roads and their courses are insufficient, modern computer-aided analyses can be of assistance. Least-cost path analyses offered the possibility to identify the most probable routes between two locations, making assumptions about modes of traffic and ease of travel. The calculated least-cost paths can differ in their course, depending on which of the two locations is the starting point or destination. Least-cost path analyses and their theoretical and methodological approaches have been carried out and discussed in numerous archeological studies in recent years.[340]

The calculation of the least-cost path is based predominantly on topographic data (digital elevation model DEM) and the positions of a starting point and a destination, which in this study were archeological sites. Other environmental data that influence movement through the landscape can be included. Slope, vegetation, hydrological data, soil types or visibility are often combined as 'costs' to an accumulated cost raster. These data are then used to calculate the 'least-cost' path between the two sites. The calculated path, however, does not represent an actual route, since numerous factors such as territorial claims, seasonal restrictions, different types of transport (e.g., on foot, on horseback, in a boat) and different modes of travel (e.g., different numbers or types of travelers) can only be considered to a limited extent in the calculation.[341] The weighting of these cost factors is also complicated.

Although the least-cost paths in this study were calculated only on the basis of slope data, the results provide important insights into the infrastructure and spatial organization of the ancient landscape in terms of trade, transport, security and.[342]

4.3.1. Topographic Data

The analysis of potential ancient route courses is highly dependent on topographic data, i.e., digital elevation models, even if they usually cannot accurately represent the ancient terrain. It is generally assumed that the higher the resolution of the digital elevation model is, the more reliable and accurate the results are.

336 Conze 1912, 61–143 (C. Schuchhardt).

337 Conze 1912, 35–42 (O. Berlet).

338 Talbert – Bagnall 2000.

339 Wittke et al. 2012.

340 E.g., White – Surface-Evans 2012; Herzog 2014b; Verhagen et al. 2014; Herzog – Schröer 2019; Parcero-Oubiña et al. 2019; Seifried – Gardner 2019; Verhagen et al. 2019, among many others.

341 Bevan 2013, 5.

342 Herzog – Posluschny 2011, 236–237; Posluschny 2012, 115.

The model used in this study is a digital elevation model from the TanDEM-X satellite mission provided by the German Aerospace Center and the European Space Agency (ESA) with a resolution of 12 × 12 m per pixel and a vertical accuracy of 2 to 4 m, depending on the slope.[343]

4.3.2. Software and Calculations

The least-cost paths were calculated in the R software[344], using the leastcostpath package[345], which uses classes and functions of the gdistance package[346]. Two cost surfaces were first calculated on the basis of the above mentioned TanDEM-X. The slope cost surface is based on Tobler's hiking equation[347] and the traversal across slope cost surface is based on Bell and Lock.[348] Both cost surfaces were weighted equally and combined into a cumulative cost raster. The resulting least-cost paths are calculated using the Dijkstra algorithm.[349]

5. Reconstruction of the Route Network in the Surroundings of Pergamon

It can be assumed that Pergamon, as one of the ancient metropolises of Asia Minor, was a central hub within the route network of the region. Routes in the Pergamon region are reconstructed here by combining all previously mentioned sources and are supported by least-cost path analyses.

Whenever routes, paths, or roads are mentioned in the following section, speak to their design and functional characteristics are not concretely defined. The connections can range from simple trails to elaborately constructed roads. This study also assumes a usage history of the routes at least in the Hellenistic and Roman Imperial periods. Whether individual routes already existed in earlier times and how long their usage history extended beyond this period cannot be clarified in this context.

In the following section, routes are named alphabetically with capital letters (A). Individual sections are numbered with the corresponding letter and a number (A1). Alternative routes are provided with an additional number (A1.1).

5.1. Route A Adramytteion – Thyateira

The route from Adramytteion (modern Edremit) to Thyateira (modern Akhisar) is already described in the *Itinerarium Antonini* (Table 5.1.1) and in the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5). Three sections of this route are analyzed here.

5.1.1. Route A1 Adramytteion – Pergamon (via Kytonion)

Pergamon could be reached using various routes through the Madra Dağı Mountains or the Kozak Mountains from the north. A well-documented route led from Adramytteion to Pergamon (Figure 5.1.6), which was already recorded at the end of the 3rd century CE in the *Itinerarium Antonini* in the context

343 Deutsches Zentrum für Luft- und Raumfahrt (DLR) 2020.

344 R Core Team 2020.

345 Lewis 2020a.

346 van Etten 2017.

347 Tobler 1993; cf. Lewis 2020a.

348 Bell – Lock 2000; cf. Lewis 2020a.

349 Dijkstra 1959.

of a route from Lampsakos to Laodikeia. In the *Tabula Peutingeriana*, this route is also mentioned, but without any distance figure.

From Adramytteion, the route left the coast and led southwards into the Madra Dağı Mountains to the plateau of the Kozak Mountains, passing Kytonion.[350] Kytonion thus formed an intermediate station on the Kozak plateau halfway between Adramytteion and Pergamon.[351] From Yukarıbey, the route continued southeast and reached the Bergama Creek (Selinos) 2.2 km north of the sanctuary of Kapıkaya. In this section, rock cuttings from the ancient road and ancient pavement were still identifiable at the beginning of the 20th century.[352] The road, whose ancient pavement was still visible even in recent times, led over a bridge (bridge 5) of *opus caementitium* at Kapıkaya along the creek to Pergamon.[353]

In the *Itinerarium Antonini,* the distance from Adramytteion to Pergamon is given as 53 miles (78.53 km; 1 mile = 1.48 km) (Table 5.1.1). The length of the reconstructed route is 71.17 km, taking the ascents into account. The difference of 7.36 km may be the result of a copyist's error in the itinerary. It is more likely, however, that inaccuracies in both the distance figure in the *Itinerarium Antonini* and the reconstructed

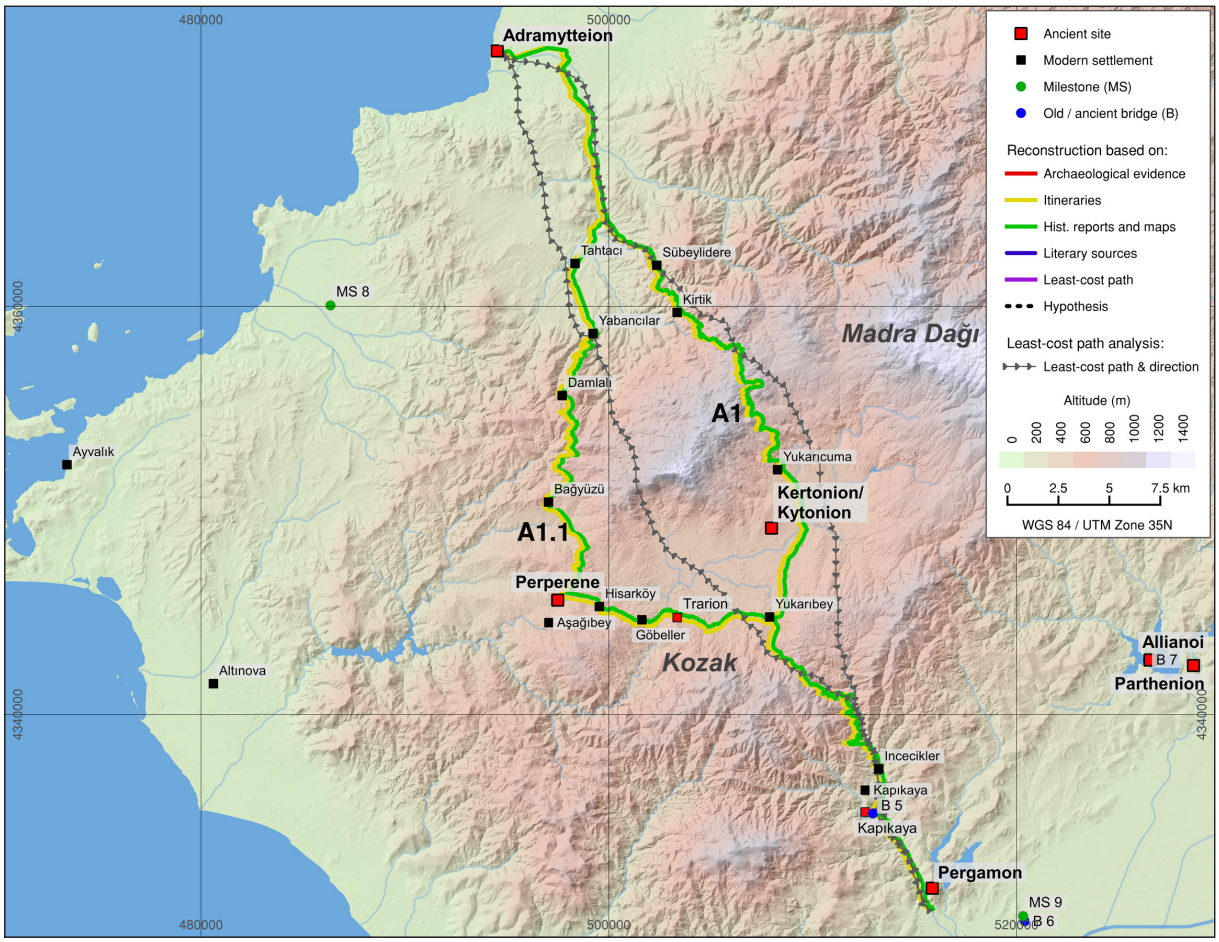

Fig. 5.1.6 Calculated least-cost paths and reconstructed routes between Adramytteion and Pergamon.

350 Fabricius 1886, 13–14; Diest 1889, 10.

351 Fabricius 1886, 13–14; Conze 1912, 124 (C. Schuchhardt).

352 Diest 1889, 9.

353 Diest 1889, 9.

route led to this difference. It is also possible that the distance figure refers to route A1.1 via Perperene (75.98 km) described below.

In 19th and 20th century maps, this route is marked as a way through the mountains.[354]

The least-cost path analysis, which was calculated from Adramytteion to Pergamon, strongly supports the probability of this route. The least-cost path shows the proposed route in an idealized form and differs only in the area of the Kozak plateau from the reconstructed route.

5.1.1.1. Route A1.1 Adramytteion – Pergamon (via Perperene)

The calculated least-cost path from Pergamon to Adramytteion runs west of the northern Kozak ridges (Figure 5.1.6). Ernst Fabricius also assumed an ancient route via Perperene[355], one of the most important settlements in the Kozak Mountains.[356] Together with Richard Bohn, he considered Perperene as well as Kytonion to be important fortresses securing the roads from Adramytteion to Pergamon.[357]

From Pergamon, the road followed the previously described course along the Bergama Creek (Selinos) to Yukarıbey. Here it branched off to the west and led along Trarion via the present-day villages of Göbeller and Hisarköy to Perperene. North of Perperene, the road is said to have crossed the mountain ridge near the village of Bağyüzü.[358]

In the *Itinerarium Antonini,* the distance from Adramytteion to Pergamon is given as 53 miles (78.53 km). With a difference of 2.55 km, this distance figure almost corresponds to the length of this reconstructed route (75.98 km).

There is no archeological evidence so far for a second parallel route connecting the western Kozak Mountains and Perperene with Pergamon.[359] However, such a route can certainly be assumed, especially since the area around Perperene contained numerous resources such as wood[360], granite, marble[361], and ores[362] that could be brought to Pergamon via these routes.

5.1.2. Route A2 Pergamon – Germe (via Apollonia)

The main route mentioned in the itineraries continued from Pergamon through the eastern lower Bakırçay Valley passing Apollonia to Germe (Figure 5.1.7). In the *Itinerarium Antonini* (Table 5.1.1) and on the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5) this route is indicated as 25 miles (37.04 km).

The exact course of the route is difficult to reconstruct. Geo-archeological studies have shown that the landscape of the lower Bakırçay Valley has changed considerably up to the present day and that the river

354 Cf. Diest 1889; Kiepert 1890; Conze 1912, 35–42 (O. Berlet).

355 Fabricius 1886.

356 Cf. Stauber 1996, 296–309 with additional literature.

357 Fabricius 1886, 2.

358 Fabricius 1886, 2; Stauber 1996, 305.

359 Stauber 1996, 304–305.

360 Pirson 2008a, 44–45.

361 Conze – Schuchhardt 1899, 148–151; Stauber 1996, 303–304; Radt 1997.

362 Strabo 13, 1, 51; Conze – Schuchhardt 1899, 148; Jones 1917–1932.

has repeatedly shifted its bed in the past.[363] The riverbed of the Bakırçay River and its tributaries has also been partially relocated, straightened, or canalized (see study area), and these activities have caused the disappearance of old paths or evidence of monuments such as ancient bridges.

Old maps show a route from the foot of the city hill of Pergamon leading east and crossing the Kestel Creek (Ketios) after about 650 m, next to the modern bridges.[364] From this point on, there are several possibilities for the course of the ancient route through the eastern lower Bakırçay Valley, which can only be reconstructed on the basis of the distance figures from the itineraries and historical maps. The most probable course leads via the present-day villages of Çiftköy, Ayaskent, and Zağnos. In ancient times, the roads from west to east (A2 Pergamon – Germe) and north to south (H Parthenion – Gambreion) likely also crossed in this area. Via Kadıköy and Bölcek, the route probably continued through the valley to Hamidiye, which lies 2 km southwest of ancient Apollonia. From Hamidiye, the route finally led to Germe, crossing the river there.

The calculated least-cost paths are not very meaningful due to the aforementioned dynamic geomorphology of the plain and the anthropogenic impacts on the landscape in the eastern lower Bakırçay Valley.

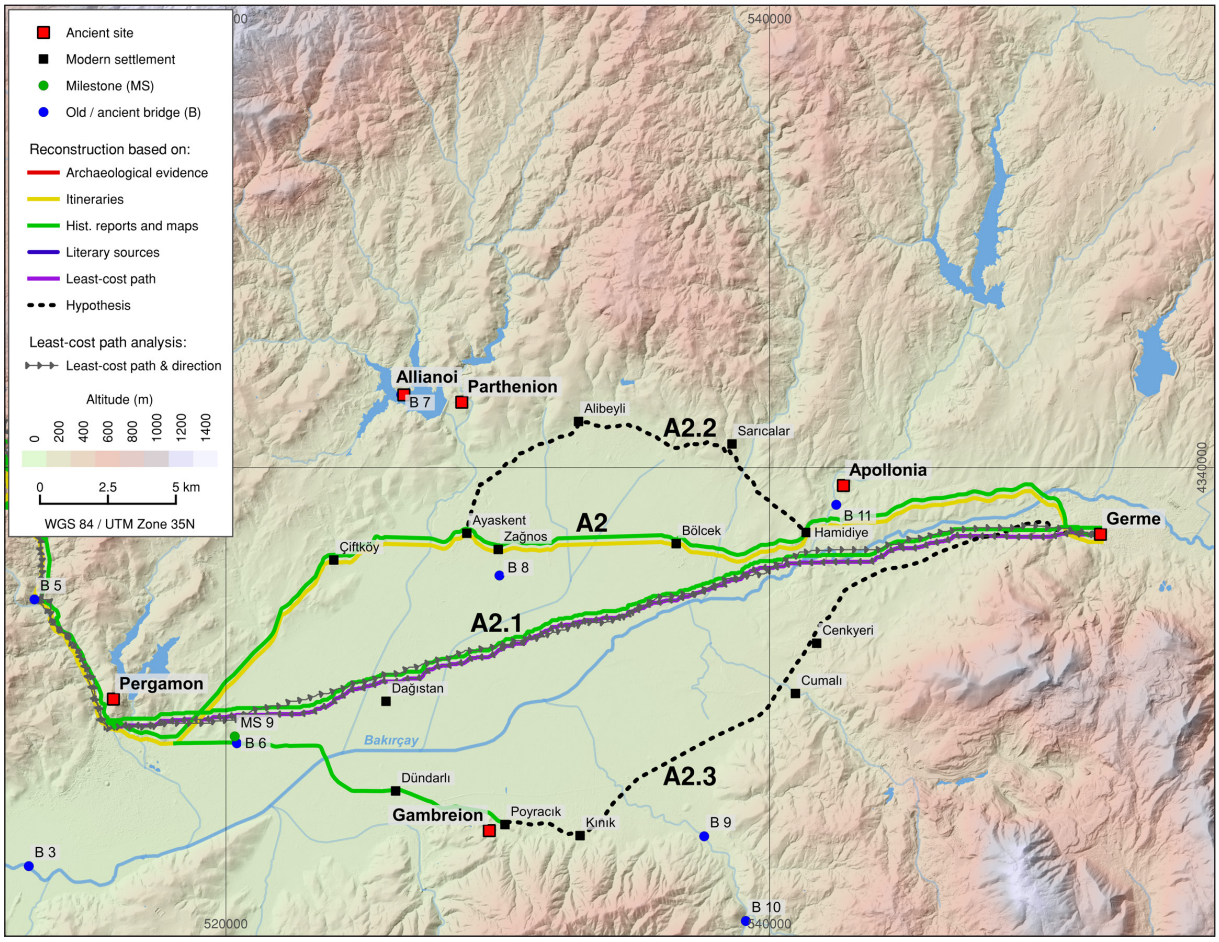

Fig. 5.1.7 Calculated least-cost paths and reconstructed routes between Pergamon and Germe.

363 Schneider et al. 2013; Schneider et al. 2014; Schneider et al. 2015.

364 Humann 1899 plan II; Conze 1912, 35–42 (O. Berlet).

The reconstructed route from Pergamon to Germe is 41.75 km long in total and thus 4.71 km longer than indicated in the *Itinerarium Antonini* and on the *Tabula Peutingeriana*. Considering the inaccurate localization of Germe and the potential inaccuracies of the itineraries, this difference is tolerable.

5.1.2.1. Route A2.1 Pergamon – Germe (through the plain)

The distance of 25 miles (37.04 km) mentioned in the itineraries correlates with the calculated least-cost path between Pergamon and Germe (40.85 km). According to these data, the route must have gone almost straight along and south of the former riverbed through the eastern lower Bakırçay Valley (Figure 5.1.7). This hypothesis is only supported by the map of Heinrich Kiepert, on which such a route can be seen.[365] The route crosses the Bakırçay River north of the present-day village of Dağıstan and leads south along the old river through the valley to Soma (Germe).

5.1.2.2. Route A2.2 Pergamon – Germe (along the northern edge of the eastern lower Bakırçay Valley)

Alternatively, this route may have led from Ayaskent further north towards Parthenion and then along the slopes of the Madra Dağı Mountains through the villages of Alibeyli and Sarıcalar on to Hamidiye (Figure 5.1.7). This is a route that offered a good alternative during the seasonal floods of the rivers in the plain and therefore may have been used at least temporarily.

5.1.2.3. Route A2.3 Pergamon – Germe (along the southern edge of the eastern lower Bakırçay Valley)

Another possibility is a route from Pergamon along the southern edge of the valley via ancient Gambreion to Germe (Figure 5.1.7). From Pergamon, the route leads east, as described above, and continues in a straight line further east over the Koyun Köprü bridge (bridge 6). It then leaves the present-day highway and leads via the village Dündarlı to Gambreion. This section between Pergamon and Gambreion had existed in antiquity, evidenced by a route leading southeast through the Yund Dağı Mountains to Apollonis (see route G1). The route east of Gambreion may have been a back road or a seasonal alternative route passing Cumalı and leading to Germe.

5.1.3. Route A3 Germe – Thyateira (via Stratonicaea/Hadrianopolis and Kalamos)

From Germe, the route mentioned in the itineraries continued to Thyateira (Figure 5.1.8). For this section, the itineraries indicate a distance of 33 miles (48.90 km). Based on this distance, a route via Stratonicaea/Hadrianopolis and Kalamos, as reconstructed by K. Rheidt, is most likely.[366] Kalamos existed at least since the Roman Imperial period, proven by a large building and a bridge (bridge 14).[367] The place was probably an important traffic junction where the road from Pergamon met the north-south connection from Hadrianoutherai to Thyateira (route F).[368]

From Kalamos, the route led south over a bridge (bridge 17), roughly following the course of the present-day road and finally reaching Thyateira.[369] Thus, the distance of the reconstructed route from Germe to

365 Kiepert 1890.

366 Rheidt 1986, 232–234.

367 Philippson 1910, 65; Rheidt 1986, 233–234.

368 Philippson 1910, 65.

369 Rheidt 1986, 232.

Thyateira is 55.36 km. It is 6.46 km longer than indicated in the *Itinerarium Antonini*, a difference that can be neglected in the light of various uncertainties.

5.1.3.1. Route A3.1 Germe – Thyateira (via Kirkağaç)

In contrast, the calculated least-cost path runs from Germe via Kirkağaç to Thyateira (Figure 5.1.8). Two milestones (MS 10) from the 3rd–4th century CE, which were found at Kırkağaç, could be related to such a route.[370] A route following this least-cost path was recently reconstructed by M. Tozan, who mentions a fortress on Dedetepe that could have controlled this road.[371] This route from Germe to Thyateira comes to a distance of just 40.40 km and is even shorter than the route via Kalamos described above. K. Rheidt, however, lists unfavorable landscape characteristics such as marshy headwaters or steep and unsafe slopes for this area.[372] Together with the significant deviations in distance from the itineraries, this route seems unlikely to have been a common historic route.

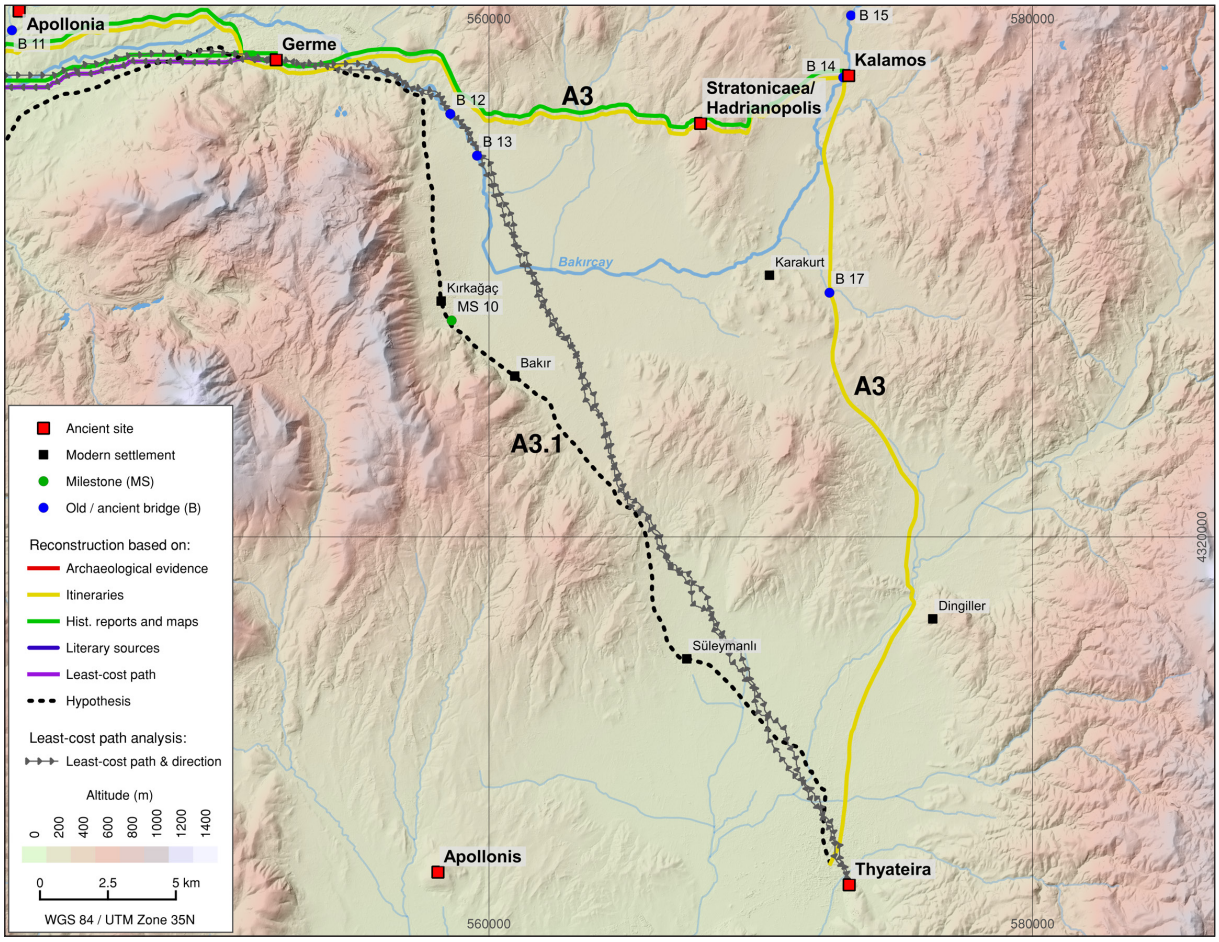

Fig. 5.1.8 Calculated least-cost paths and reconstructed routes between Germe and Thyateira.

370 French 2014, 181–182.

371 Tozan 2017, 541–547.

372 Rheidt 1986, 232–233.

5.2. Route B (Ephesus –) Gryneion – Pergamon (via Elaia)

The route from Ephesus to Pergamon was probably already important under Attalid rule and was built or extended as a Roman road during the establishment of the province of Asia Minor under Manlius Aquilius.[373] Several milestones[374] from the 1st–4th century CE found in the area of Zeytindağ, Elaia (MS 2), Tekkedere (MS 3), and Kurfallı (MS 4) give evidence for the connection between Pergamon and Ephesus, which is also depicted in the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5) and are subsequently discussed only in its last section from Gryneion via Elaia to Pergamon.

5.2.1. Route B1 Gryneion – Elaia and around Elaia

The coastal route roughly followed the course of today's highway. Coming from the south, it first passed the tumulus on Seç Tepe and the fortress on Sakarkaya at some distance (Figure 5.1.9). The ancient route then passed east of Elaia, circumnavigating its city walls. Its course is probably also the same as today's highway (Figure 5.1.10). From the eastern city gate, the route ran through the north-eastern necropolis and past the Bozyer Tepe into the Bakırçay Valley.[375] Under the rule of Vespasian, repairs were carried out in the area of this road section, as evidenced by an inscription.[376] North of the Bozyer Tepe, a route then branched off to the west and led to a Roman bridge (bridge 1) over the Bakırçay River.

From the north-western city gate of Elaia, a road paved with pebbles led through the north-western necropolis of Elaia to the southern slopes of the Bozyer Tepe.[377] Due to the higher sea level in antiquity[378] it can be assumed that the road ran through the necropolis[379], passing the tumulus on the Bozyer Tepe[380], and continued to the bridge (bridge 1) over the Bakırçay River.

Another road, identified by geophysical measurements, also led from the north-western city gate to the north-east, where it joined the main road to Pergamon.[381]

5.2.2. Route B2 Elaia – Pergamon (via bridge 3)

North of Elaia, the ancient route ran along the southern edge of the Bakırçay Valley (Figure 5.1.11), like the highway does today, and was flanked by graves and tumuli. Road construction work north of Elaia revealed two stone cist tombs from the Hellenistic period[382] and an ancient tumulus near Kurfallı, shown on O. Berlet's map.[383]

South of Eğrigöl Tepe, an ancient bridge (bridge 2) crossed the river. From this location on, there are two possibilities for the continuation of the route to Pergamon. The route may have continued further east

373 Heinle 2015, 34–35.
374 French 2014, 62–69.
375 Feuser (in press).
376 Heinle 2015, 35.
377 Feuser (in press).
378 Seeliger et al. 2013.
379 Pirson 2009, 185–188.
380 Pirson 2010, 202–208 (S. Feuser – A. Sarıoğlu).
381 Feuser (in press).
382 Pirson 2012b, 248 (F. Pirson – A. Sarıoğlu).
383 Conze 1912, 35–42 (O. Berlet).

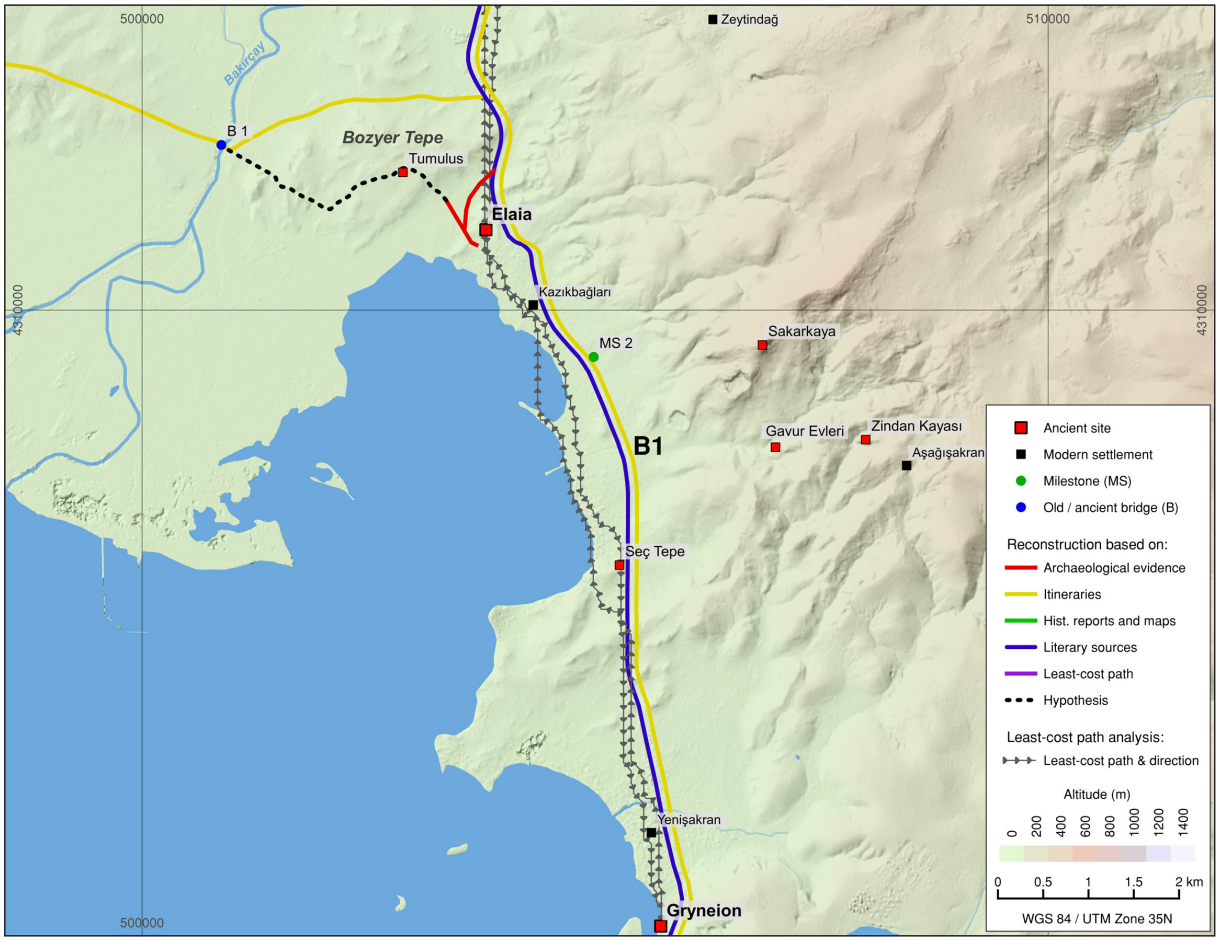

Fig. 5.1.9 Calculated least-cost paths and reconstructed route between Gryneion and Elaia.

Fig. 5.1.10 Foreground: Harbor basin of Elaia. Background: Highway leading past Elaia into the western lower Bakırçay Valley and to Bergama (Pergamon) similar to the ancient route B.

and crossed the river at bridge 3, running straight on until it turned north about 1 km southwest of the present-day outskirts of Bergama and reached the foot of the ancient city hill. Just before the ancient city, the route passed numerous tumuli, such as X-Tepe, Yığma Tepe, Tumuli 3 and 2 and Maltepe.

The entire city façade of Pergamon, with its large buildings such as the Trajaneum, the Temple of Athena, or the Great Altar, was oriented towards this route. This created an enormous long-distance effect for travelers moving along the road long before they reached city.[384]

In the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5), the distance from Elaia to Pergamon is given as 16 miles (23.71 km). The route reconstructed here has a length of 24.64 km and correlates almost exactly to the recorded distance. The difference of 930 m may be the result of rounding errors or the result of measuring from the city gate and not from the city center in antiquity.

The route between Elaia and Pergamon can be assumed to be reliable in its course and was one of the most important traffic connections for Pergamon. Only the section between the Eğrigöl Tepe and Pergamon still allows space for discussion due to the current state of research.

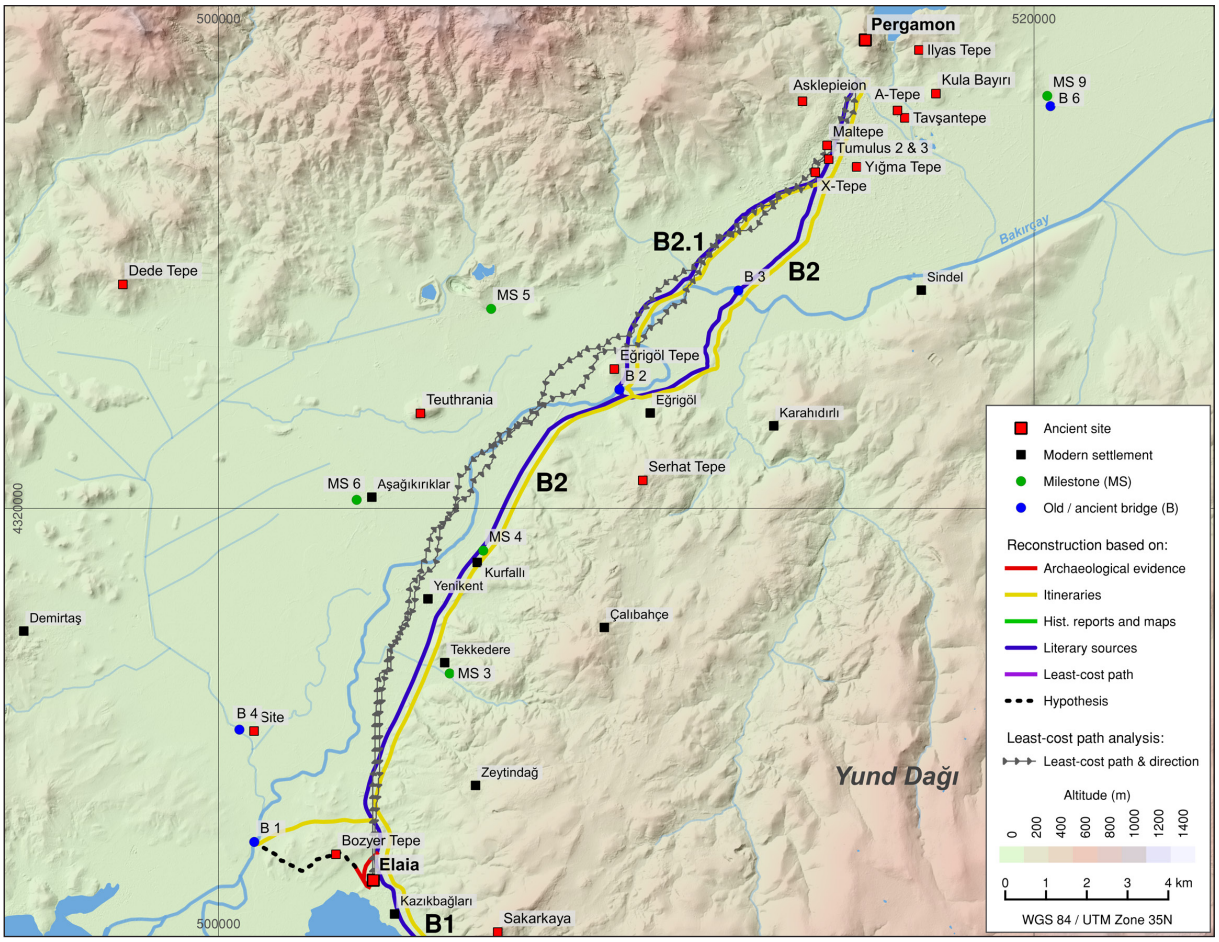

Fig. 5.1.11 Calculated least-cost paths and reconstructed routes between Elaia and Pergamon.

384 Cf. Wulf 1999; Pirson 2012a; Pirson – Ludwig (in press).

5.2.2.1. Route B2.1 Elaia – Pergamon (via bridge 2)

An alternative route from Eğrigöl Tepe to Pergamon ran further north. Starting at the ancient bridge 2 south of Eğrigöl Tepe and passing the hill to the east, it reached Pergamon after 24.63 km (Figure 5.1.11). Both routes had the same distance and could have been used at the same time. If one of the routes has been temporarily impassable, for example due to seasonal flooding of the Bakırçay River[385], the important connection to Elaia would still have been ensured via the parallel route.

The calculated least-cost paths between Elaia and Pergamon correspond almost exactly to the reconstructed route.

5.3. Route C Adramytteion – Elaia

The *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5) shows a road connection from Adramytteion along the coast and the eastern slopes of the Kara Dağı Mountains to Elaia, where it meets the previously described road from Ephesus to Pergamon (route B). Andreas Külzer last reconstructed a course along the coast, passing Atarneus and leading along the northern edge of the Bakırçay Valley to Pergamon (Figures 5.1.12 and 5.1.13).[386] Such a route, in the form of a well-developed road from Atarneus to Pergamon (route L), of supra-regional importance, has not yet been proven.

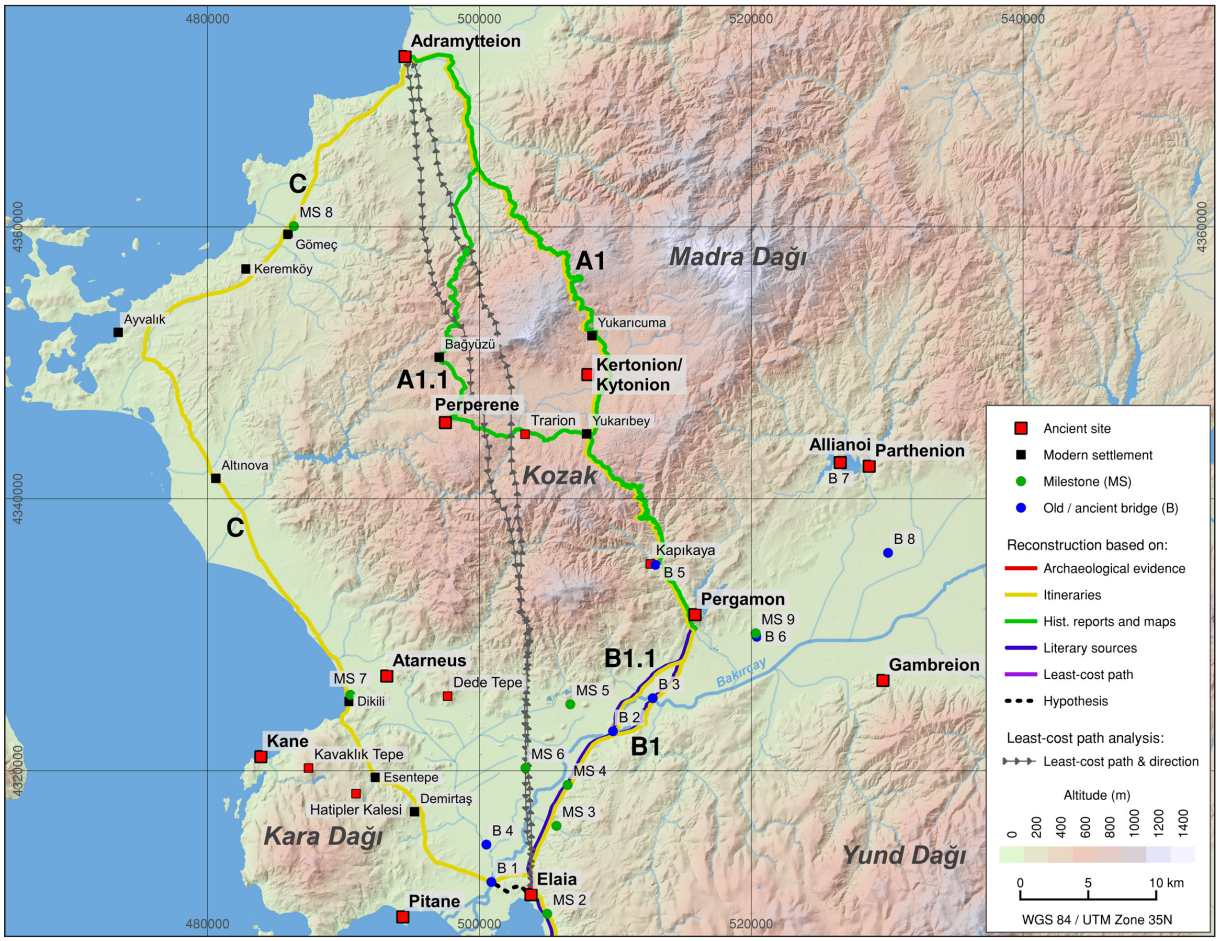

Fig. 5.1.12 Calculated least-cost paths and reconstructed route between Adramytteion and Elaia.

385 Schneider et al. 2013; Schneider et al. 2014; Schneider et al. 2015.

386 Külzer 2016, 194.

Fig. 5.1.13 Atarneus. Left: Coastline west of Atarneus and northern outskirts of present-day Dikili. Right: Narrow passage into the western lower Bakırçay Valley between Kozak and Kara Dağı Mountains.

A milestone (MS 7) was found in the 19th century during the construction of the new road from Dikili to Bergama (Pergamon), but its original location is ambiguous and therefore does not provide much information for the reconstruction of the routes.[387]

The least-cost paths between Adramytteion and Elaia do not run along the coast, but through the Kozak Mountains passing Perperene (Figure 5.1.12). Although at first glance this seems a rather unlikely route, the length of the least-cost paths (67.6 km) correlates surprisingly well with the distance of 45 miles (66.68 km) mentioned in the *Tabula Peutingeriana*. Nevertheless, it is most likely that the route from Adramytteion to Atarneus ran along the coast. Due to the topographical situation of the Kara Dağı Mountains and the swampy depression south-east of Atarneus, the route probably led along the present-day villages of Esentepe and Demirtaş to Elaia, as the present-day road does.

This reconstructed route has a length of 82.30 km, which corresponds to 55 miles. On the *Tabula Peutingeriana* the route from Adramytteion to Elaia is indicated as 45 miles (Table 5.1.2, Figure 5.1.5). It is most likely, that 10 miles were lost due to a copying error on the section "[?]tto (Adramytteion) – 15 miles – Corifanio – 5 miles – Elatia – 15 miles – Attalia – 10 miles – Ela (Elaia)".

5.4. Route D (Cyzicus –) Ergasteria – Pergamon

In the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5) another road is shown that led directly from Cyzicus at the Sea of Marmara to Pergamon and was analyzed only between Ergasteria and Pergamon.

5.4.1. Route D1 Ergasteria – Pergamon (via Parthenion and Allianoi through the Bakırçay Valley)

The distance between Ergasteria, which is located near today's Balya, and Pergamon, as given in the *Tabula Peutingeriana,* is 35 miles (51.86 km).[388] The actual distance between Ergasteria and Pergamon, however, is much greater. The least-cost paths calculated between the two places instead have a length of about 90 km (Figure 5.1.14). They are almost twice as long as those shown in the *Tabula Peutingeriana* and correspond to the distance of 440 stadia (about 81 km) mentioned by Galen.[389] Apart from these

387 French 2012, 9–10.

388 Külzer 2016, 197.

389 Galen 12, 230; Kühn 1821–1833.

distances, there are no other indications of an ancient route available. The route can nevertheless be located in the area of the least-cost paths with high probability. It may have led via today's Ivrindi to Allianoi and Parthenion and continued through the Bakırçay Valley on the previously reconstructed route between Pergamon and Germe (route A2).

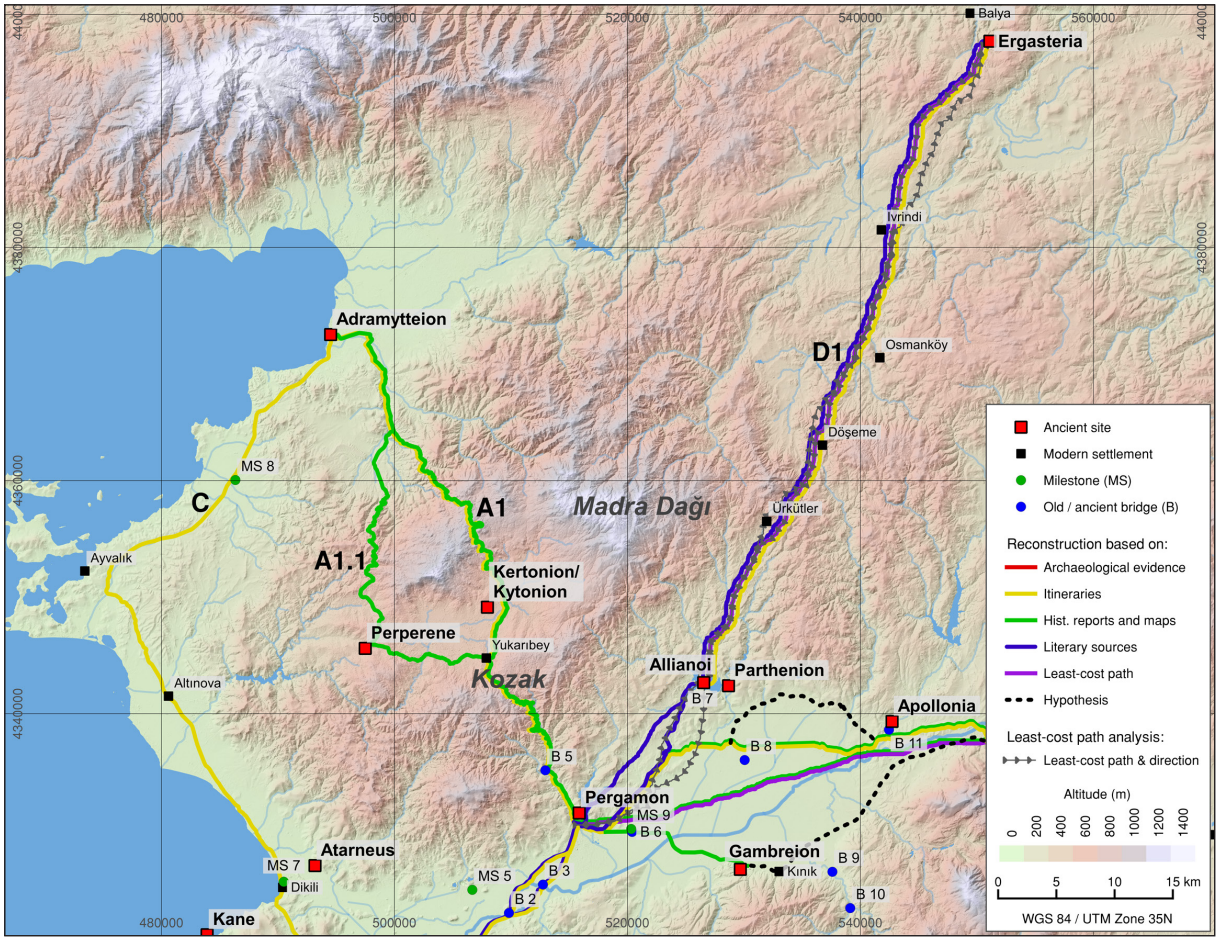

Fig. 5.1.14 Calculated least-cost paths and reconstructed routes between Ergasteria and Pergamon.

5.4.1.1. Route D1.1 Ergasteria – Pergamon (via Parthenion and Allianoi through the Kestel Creek Valley)

For the section between Allianoi and Pergamon, Galen gives a distance of 100 stadia (18.6 km) and thus allows for conclusions about said course (Figure 5.1.15).[390] The sections of the least-cost paths between Allianoi and Pergamon and the reconstructed route from Allianoi through the Bakırçay Valley have distances of about 20 km and correspond to the round number of 100 stadia of Galen. An alternative route with about 18 km, which would also correspond to Galen's specifications, can have led through the Kestel Creek Valley (Ketios Valley) and along the Niyazitepe, where a Roman grave monument is located.[391] Both routes, the one through the Bakırçay Valley and the one through the Kestel Creek Valley, are therefore likely to have existed.

390 Galen 6, 424; Kühn 1821–1833.

391 Karagöz et al. 1986.

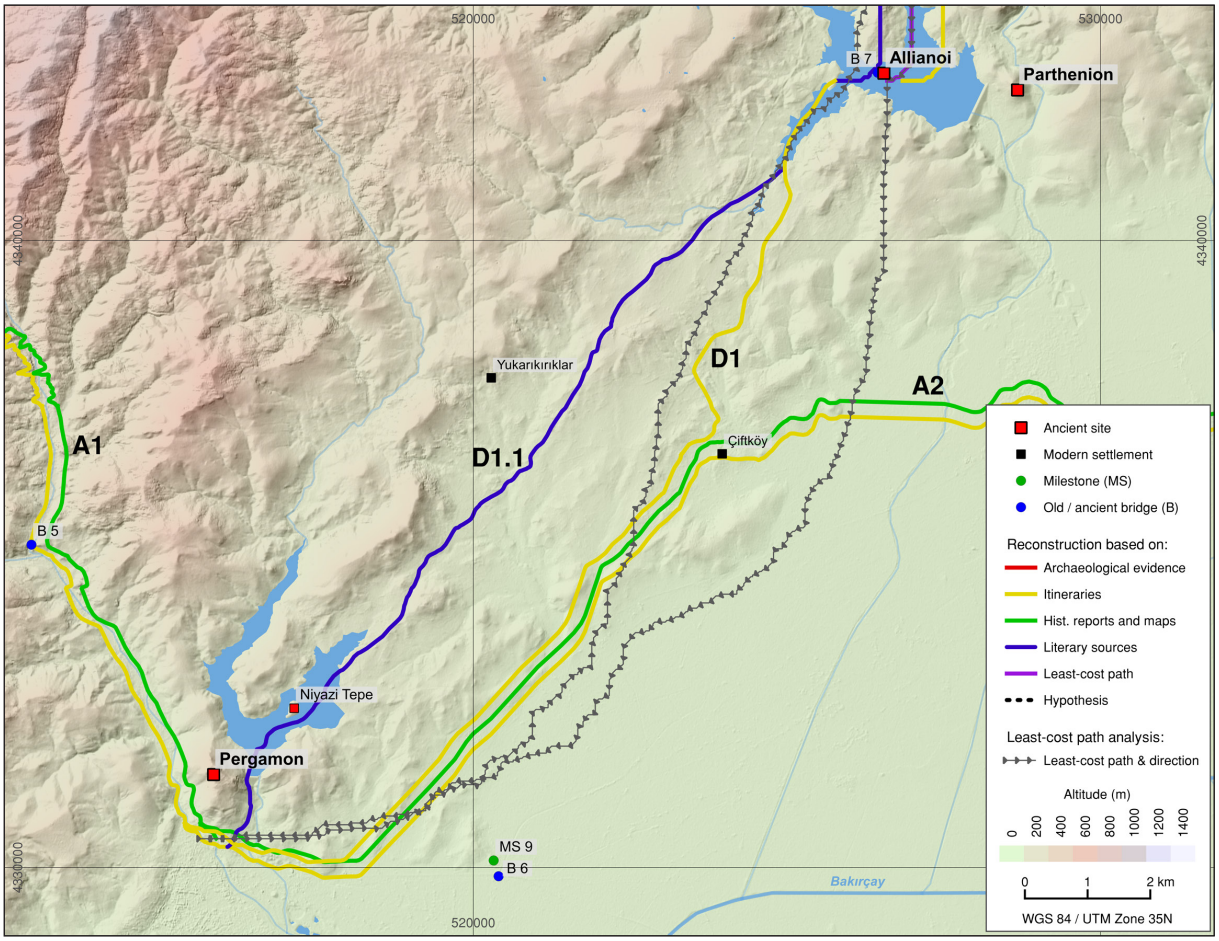

Fig. 5.1.15 Sections between Allianoi, Parthenion, and Pergamon of the calculated least-cost paths and reconstructed routes between Ergasteria and Pergamon.

5.5. Route E Hadrianoutherai – Pergamon

5.5.1. Route E1 Hadrianoutherai – Apollonia

A road from Hadrianoutherai (modern Balıkesir) to Pergamon with a distance of 8 miles (11.85 km) is shown in the *Tabula Peutingeriana* (Table 5.1.2, Figure 5.1.5).[392] The distance figure must be incorrect, since the reconstructed route gives a length of about 100 km. This may be the result of a copyist's error. The distance figure LIII (78.44 km) may have been mis-copied to VIII (11.85 km) during one of the copying stages of the *Tabula Peutingeriana*. Even assuming such an error, the reconstructed route would still be about 20 km longer than shown on the map. Due to the lack of evidence, only the least-cost path analysis can be used to reconstruct the route between the two locations. However, the ancient road will most likely be found in the area of the calculated paths (Figure 5.1.16).

5.5.2. Route E2 Apollonia – Pergamon (=A2)

In Apollonia, the road coming from Hadrianoutherai met the east-west connection between Pergamon and Germe, which was already described as route A2 (Figures 5.1.7 and 5.1.16).

392 Cf. Talbert – Bagnall 2000; French 2016; Tozan 2017.

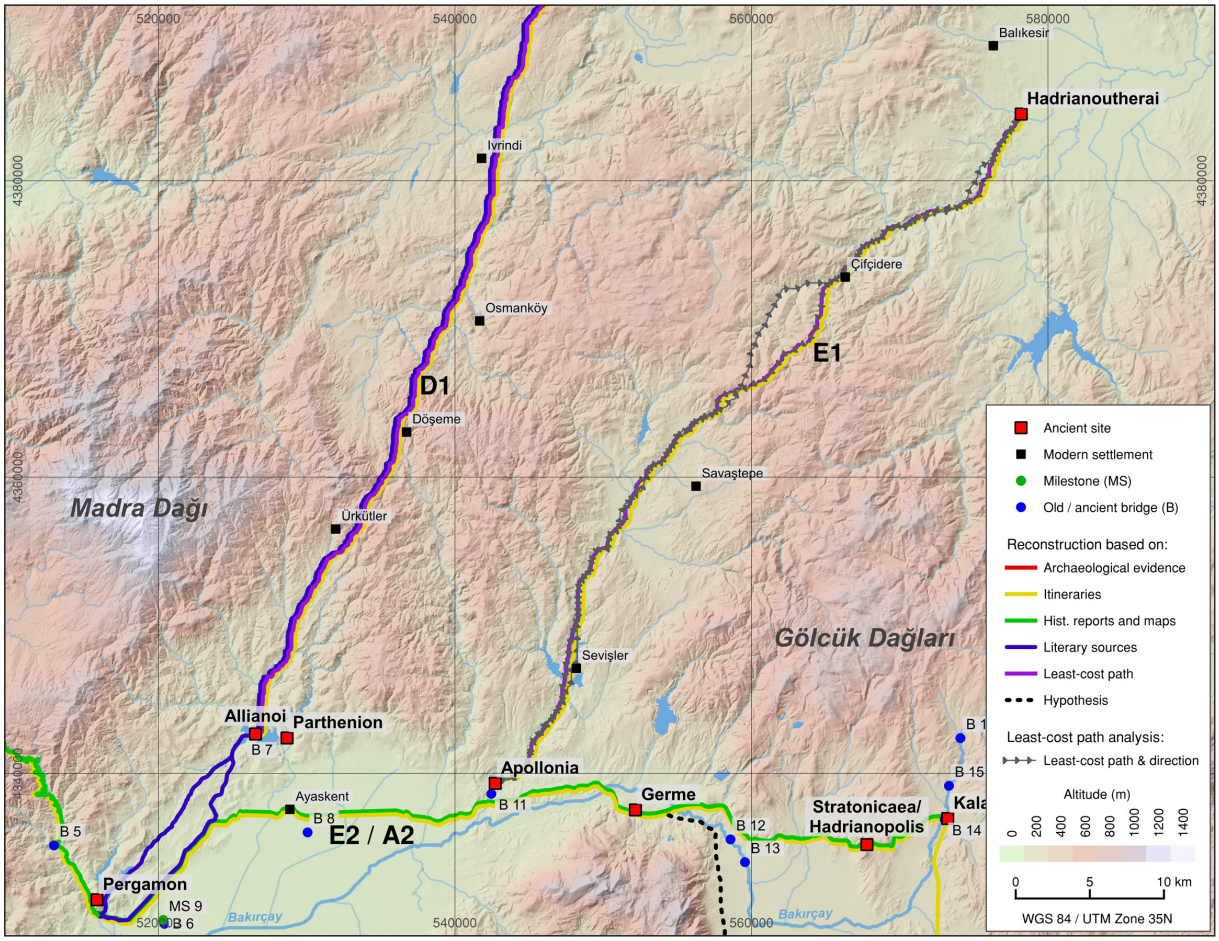

Fig. 5.1.16 Calculated least-cost paths and reconstructed route between Hadrianoutherai and Apollonia.

5.6. Route F Hadrianoutherai – Thyateira

5.6.1. Route F1 Hadrianoutherai – Kalamos

From Hadrianoutherai, another road led to Thyateira (Akhisar) via Kalamos (Gelembe) (Figure 5.1.17). The route is not mentioned in any of the itineraries and probably gained importance only in Byzantine times.[393]

The least-cost path runs from Hadrianoutherai slightly southwest and straight on through the mountains to Thyateira, passing Kalamos on the way. The reconstructed route, on the other hand, runs in an arc along the river valleys further east. It can be reconstructed from various sources and remains of bridges (bridge 15 and 16) in the area.[394]

5.6.2. Route F2 Kalamos – Thyateira (=A3)

The route between Kalamos (Gelembe) and Thyateira (Akhisar) corresponds to route A3, which was described above (Figures 5.1.8 and 5.1.17).

393 Rheidt 1986, 231.

394 Diest 1889, 20; Rheidt 1986, 232; Tozan 2017, 542.

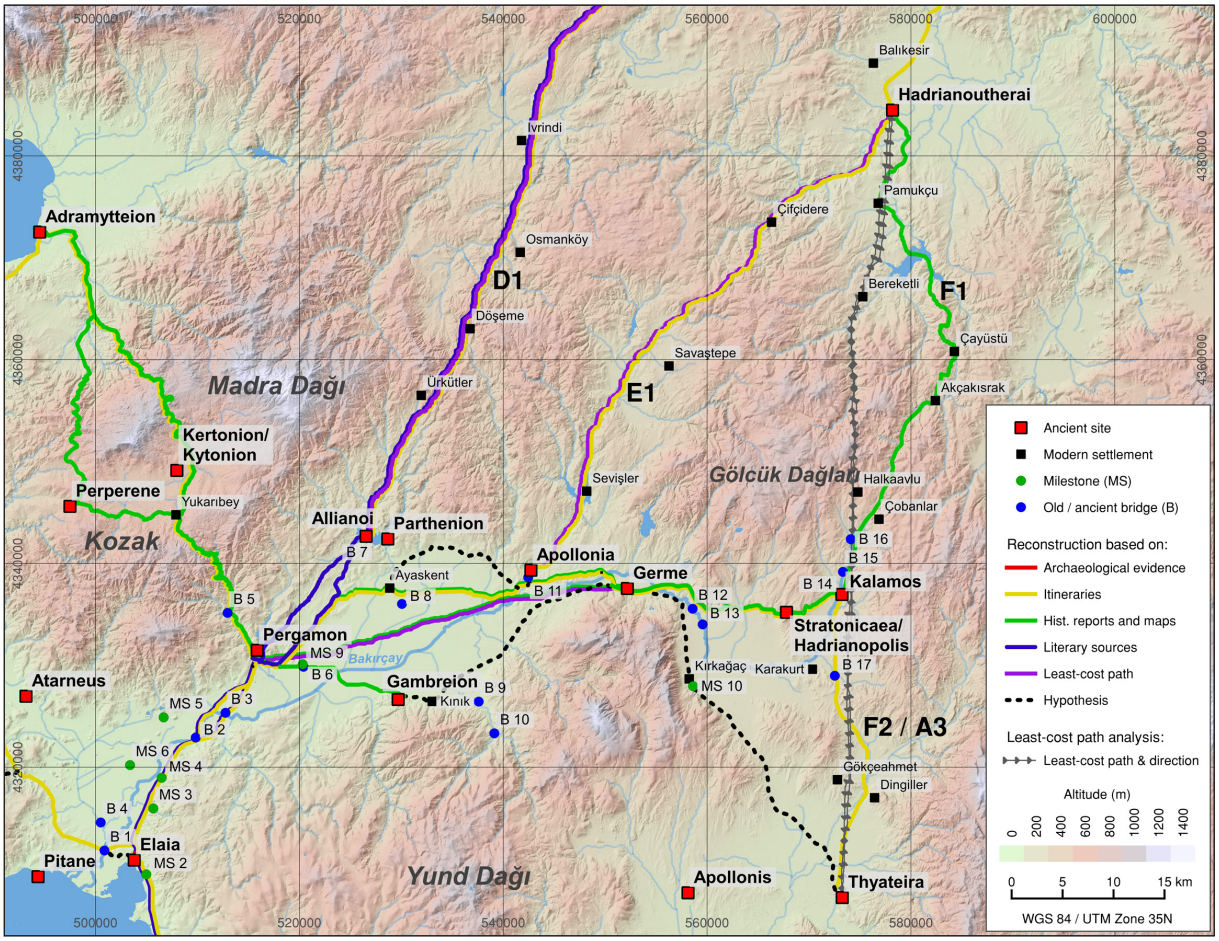

Fig. 5.1.17 Calculated least-cost paths and reconstructed route between Hadrianoutherai and Thyateira via Kalamos.

5.7. Route G (Sardis –) Apollonis – Pergamon

5.7.1. Route G1 Apollonis – Gambreion

From Apollonis, a road led through the Yund Dağı Mountains into the eastern lower Bakırçay Valley and to Pergamon (Figure 5.1.18). Strabo mentions a distance between Apollonis and Pergamon of 300 stadia (55.8 km), which indicates a course through the mountains and not through the Bakırçay Valley.[395] W. von Diest describes a road with ancient pavement and a width of 5 m leading from Apollonis into the mountains and probably to Gambreion.[396] K. Rheidt considers this route as a gateway for Turkish tribes from the Yund Dağı Mountains into the lower Bakırçay Valley in Byzantine times and mentions a fortress at Kızılhisar.[397]

The least-cost path from Apollonis to Gambreion runs through the river valleys via Elmadere. In the opposite direction, the path runs slightly further east via today's Yaylaköy, similar to the route reconstructed by M. Tozan and shown by O. Berlet.[398] On the northern side of the Yund Dağı Mountains,

395 Strabo 13, 4, 4; Jones 1917–1932.

396 Diest 1889, 25; Conze 1912, 105–106 (C. Schuchhardt).

397 Diest 1889, 15; Conze 1912, 130–131 (C. Schuchhardt); Rheidt 1986, 231–232.

398 Conze 1912, 35–42 (O. Berlet); Tozan 2017, 563.

the least-cost paths run through the valley of the Karadere Creek, past the aforementioned fortress at Kızılhisar into the lower Bakırçay Valley and to Gambreion. The calculated least-cost paths between Apollonis and Gambreion can be assumed as the probable route.

5.7.2. Route G2 Gambreion – Pergamon

Although Gambreion was located halfway between Pergamon and Germe, near present-day Poyracik and Kınık, it probably played a minor role as a stopover between those places, since the main route (route A2) ran north of the Bakırçay River in antiquity (Figure 5.1.7).[399] As the first larger settlement north of the Yund Dağı Mountains, Gambreion was instead an important stopover for travelers coming from Apollonis (Figure 5.1.18). From Gambreion, the route continued northwest where it crossed the Bakırçay River and further on another tributary (see also route A2.3) in the area of the Ottoman Koyun Köprü (bridge 6). Next to the bridge, a milestone (MS 9) dating back to the 4th century CE and with Pergamon as the starting point (caput viae), was discovered in the 19th century. From the bridge, the route ran to the west, where it met the route coming from Parthenion, Germe and Apollonia (route A2).

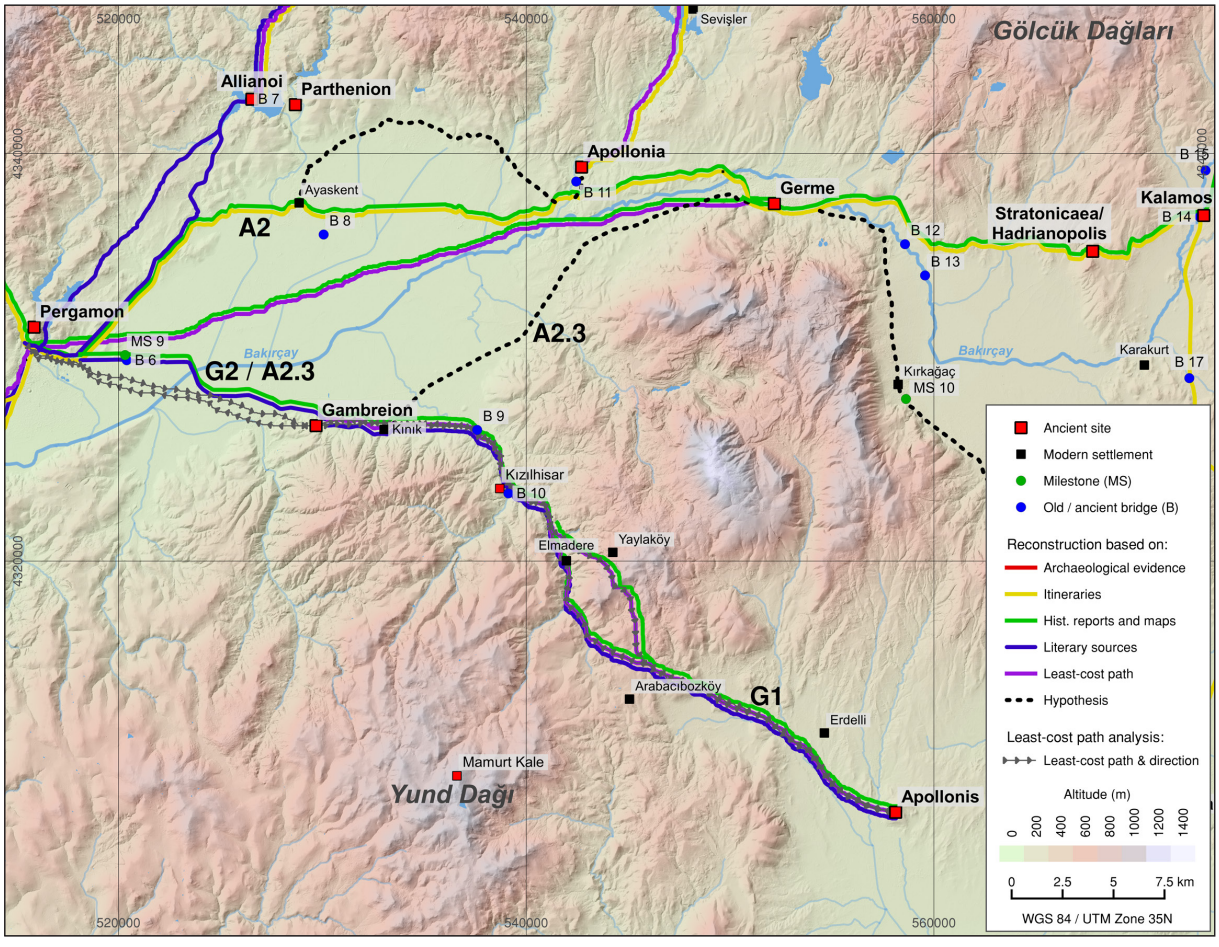

Fig. 5.1.18 Calculated least-cost paths and reconstructed routes between Apollonis and Pergamon via Gambreion.

399 Conze 1912, 130 (C. Schuchhardt).

5.8. Route H Parthenion – Gambreion

It can be assumed that Gambreion and Parthenion, as the largest settlements in the eastern lower Bakırçay Valley, were also connected by a route (Figure 5.1.19). Several bridges and fords are known in this area from the 19th century, over which the route through the plain may have passed.[400] Also worth mentioning is a Byzantine bridge (bridge 8) south of Zağnos, which possibly originates from an ancient predecessor. The calculated least-cost path leads east of the bridge via Ayaskent. Although the result of the least-cost analysis must be interpreted with great caution due to the landscape changes and the repeated shifting of the river bed (see study area), the ancient route was probably within the range of the least-cost path, the bridge and the reconstructed route.

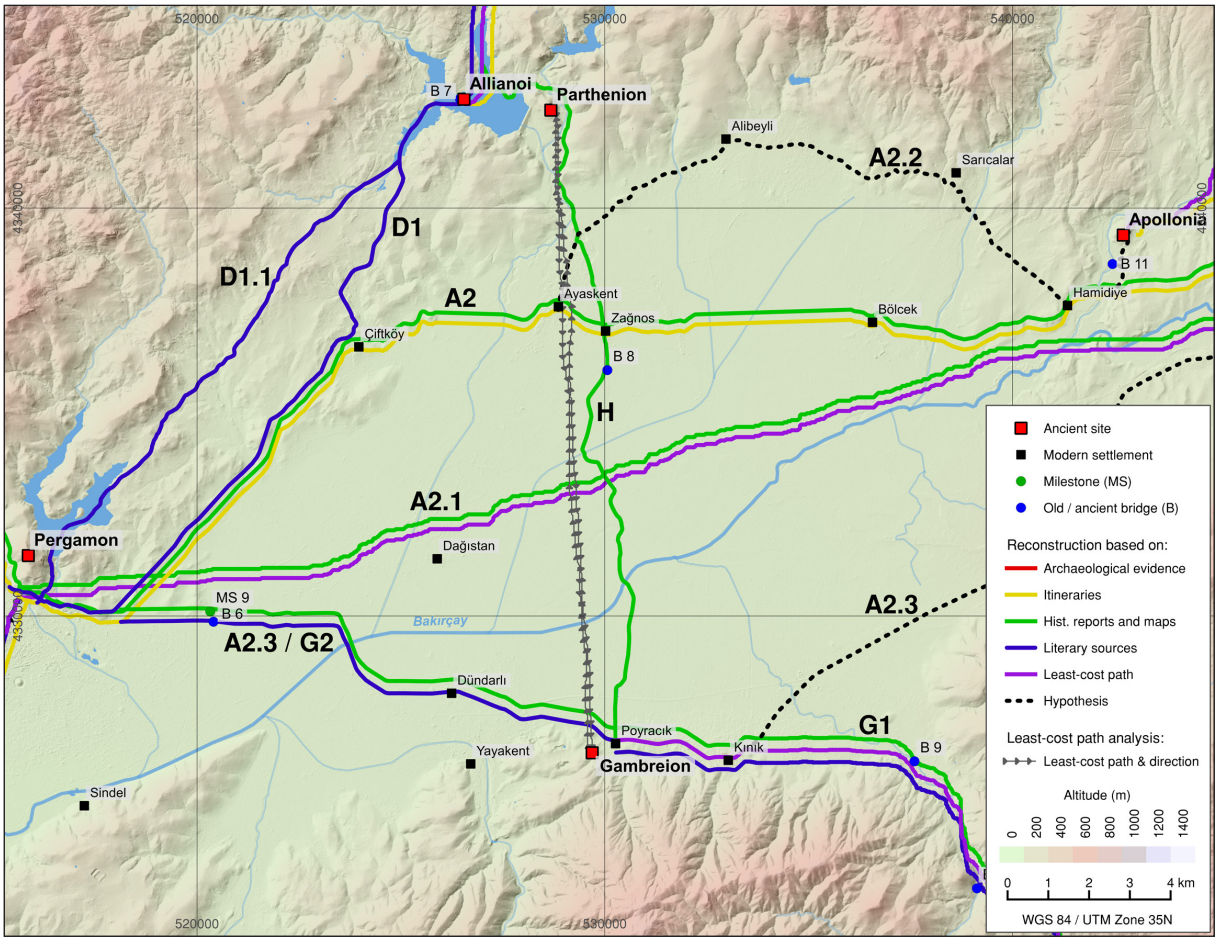

Fig. 5.1.19 Calculated least-cost paths and reconstructed route between Parthenion and Gambreion.

5.9. Route I Magnesia – Pergamon

From ancient Magnesia (modern Manisa), located in the Hermos Plain, a route led through the Yund Dağı Mountains to Pergamon (Figure 5.1.20).[401] It was recently reconstructed by M. Tozan via the present-day villages of Demirci, Recepli, and Örtülü.[402] The route passed the highest peaks of the Yund Dağı Mountains

400 Diest 1889, 15.

401 Diest 1889, 25; Philippson 1910, 74–75.

402 Tozan 2017, 554.

and the sanctuary in Mamurt Kale, one of the most important extra-urban sanctuaries of Pergamon. The site had direct lines of sight to Pergamon and a road connection to the city hill can also be assumed from the extension of the sanctuary under Philetaerus.[403]

The calculated least-cost paths run further west and offer another option for the way through the Yund Dağı Mountains.

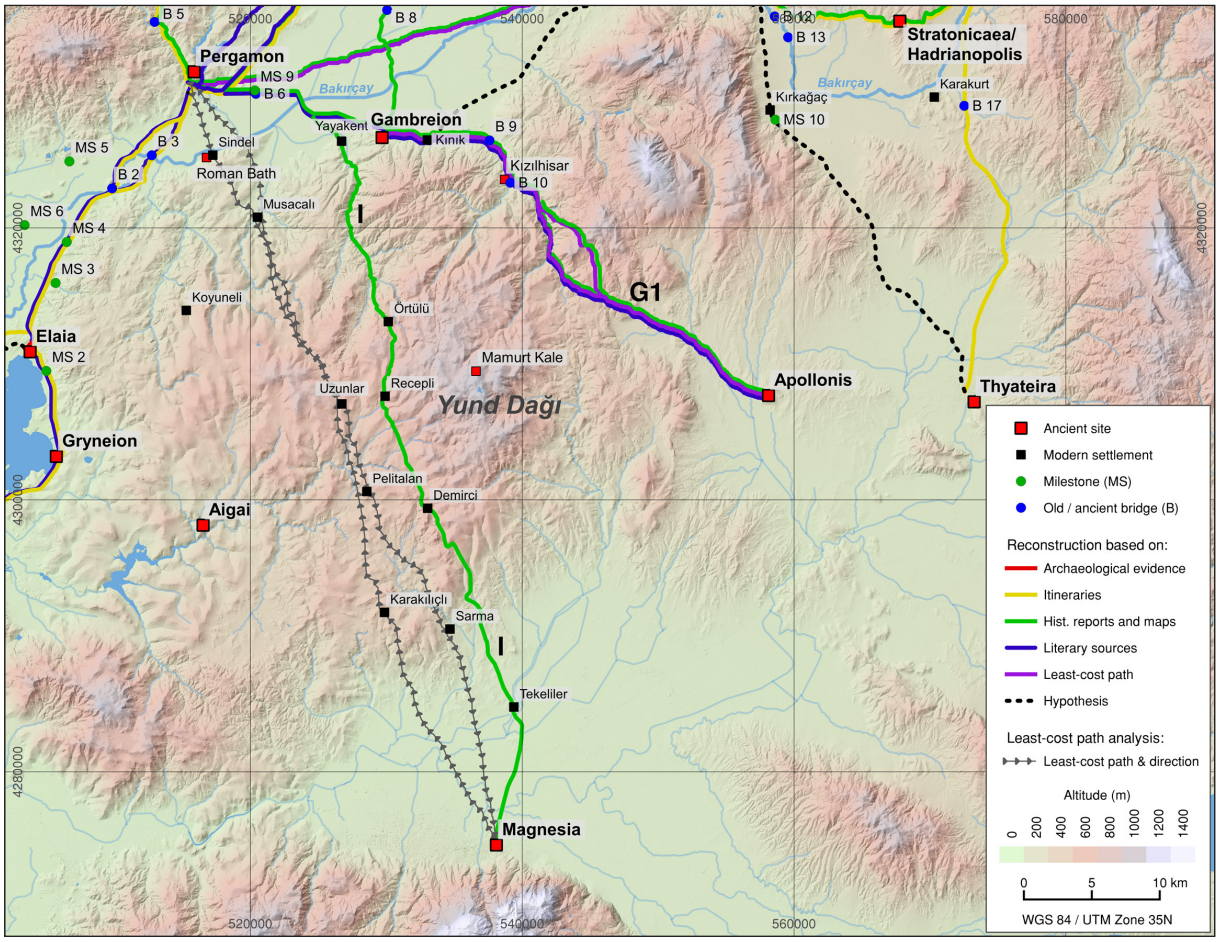

Fig. 5.1.20 Calculated least-cost paths and reconstructed route between Magnesia and Pergamon.

5.10. Route J Aigai – Pergamon

5.10.1. Route J1 Aigai – Pergamon

The largest ancient settlement in the Yund Dağı Mountains was Aigai (Figure 5.1.21), which must have had a road connection to Pergamon. The main route between the two cities probably followed an old road from Aigai via Ismailli and along a ridge to Maruflar.[404] The route continued northwest down into the valley of Değirmendere and followed the creek until reaching the road from Elaia to Pergamon (route B2). Then 1 km southwest of Karahıdırlı, the route passed a Hellenistic fortress or watchtower, which was located on a hill above the valley and served as a checkpoint at the entrance to the Bakırçay Valley.[405]

403 Conze – Schazmann 1911; Williamson 2014a.

404 Diest 1889, 27.

405 Pirson 2018, 167–168 (B. Ludwig – F. Pirson).

In addition, there was another fortress with the same function in the valley dating back to the Roman Imperial period.[406] Both sites underline the importance of this route.

The calculated least-cost paths connect Aigai and Pergamon almost directly and give no further hints for the reconstruction of the ancient route.

5.10.1.1. Route J1.1 Aigai – Pergamon (eastern route)

From Maruflar, another route went further east via Gaylan and Sindel to Pergamon (Figure 5.1.21).[407] Just outside of Sindel, remains of a thermal bath dating back to the Roman Imperial period can be found right next to the present-day road to Bergama.[408] Such a route was recently reconstructed by M. Tozan as well.[409]

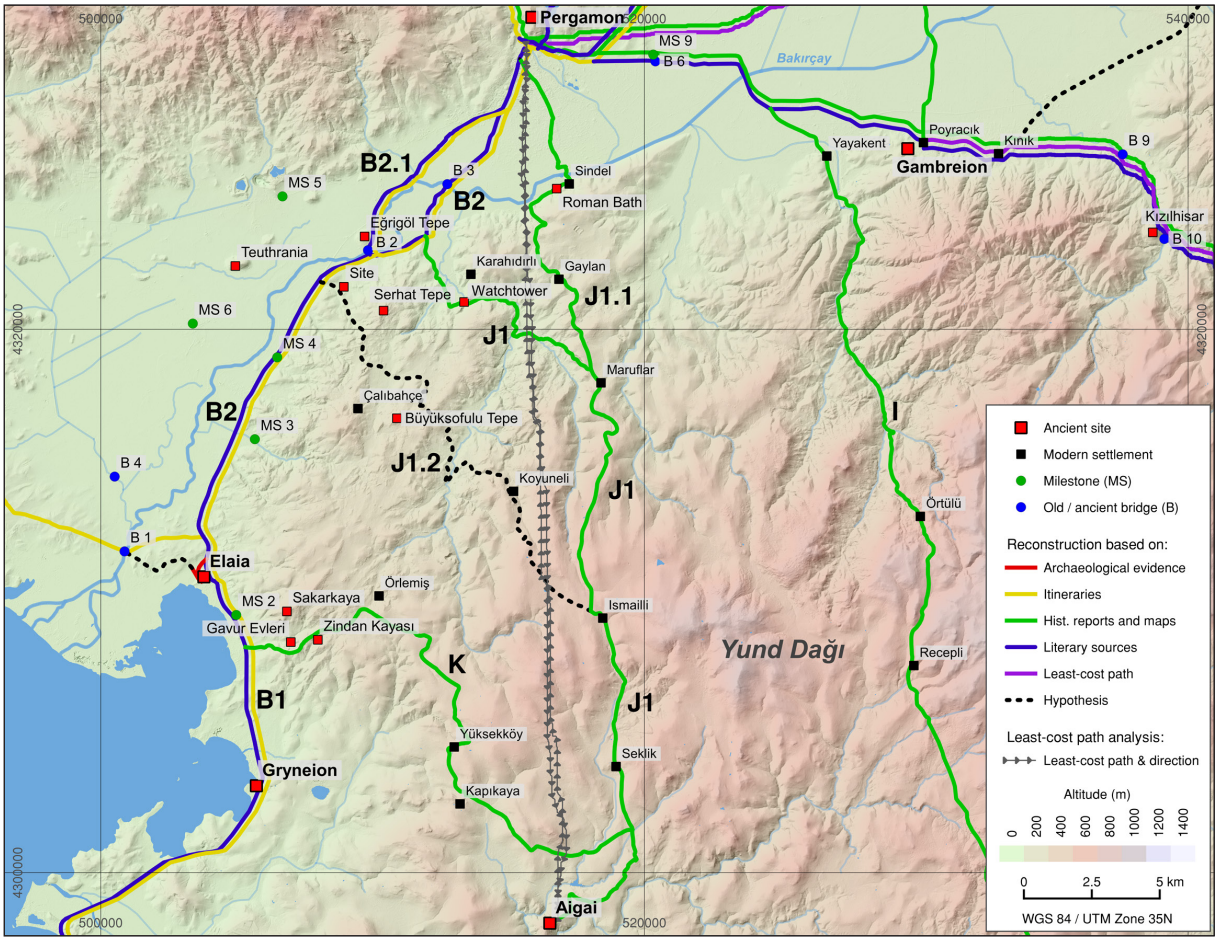

Fig. 5.1.21 Calculated least-cost paths and reconstructed routes between Aigai and Pergamon and between Aigai and the ancient coastal route.

406 Diest 1889, 28; Conze 1912, 117 (C. Schuchhardt).

407 Diest 1889, 27.

408 Conze 1912, 129–130 (C. Schuchhardt); Pirson 2018, 168 (B. Ludwig – F. Pirson).

409 Tozan 2017.

5.10.1.2. Route J1.2 Aigai – Pergamon (western route)

Another route from Aigai to Pergamon branched off to the west at Ismailli and continued to Koyuneli, where a fortress controlled the route in Byzantine times (Figure 5.1.21).[410] K. Rheidt and M. Tozan reconstruct this route from Koyuneli further on to Karahıdırlı.[411] As an alternative route to the two previously described, a course through the basin northeast of Çalıbahçe is more conceivable. This route would have instead passed the Hellenistic watchtowers on Büyüksofulu Tepe[412] and on Serhat Tepe[413], which were intentionally built to control the region and the route (Figure 5.1.22). Further on its course, the road would have passed a large Roman villa before it joined the road from Elaia and Pergamon (route B).[414]

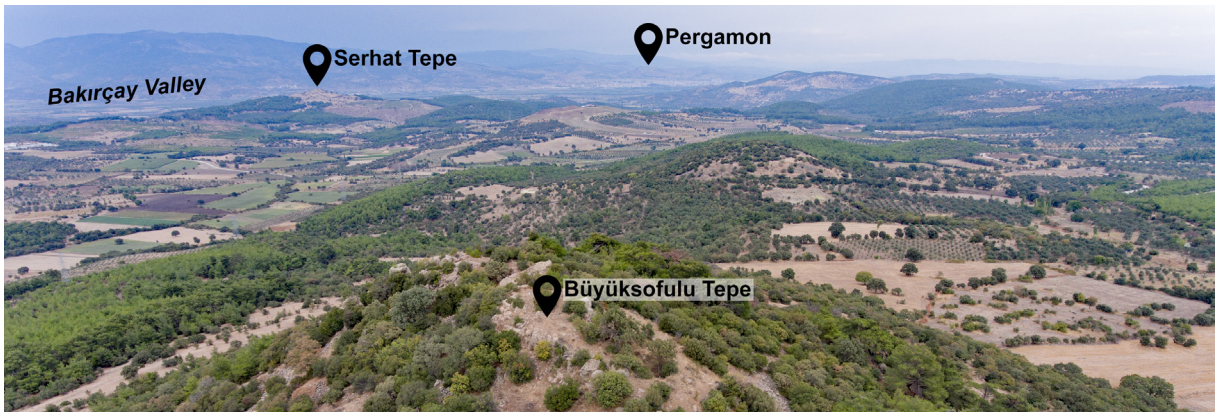

Fig. 5.1.22 View from the fortress on Büyüksofulu Tepe to the north. Route J1.2 ran from east (right) to west (left) into the Bakırçay Valley passing between Büyüksofulu Tepe and Serhat Tepe.

5.11. Route K Aigai – Coastal road (Elaia)

From Aigai, another road led through the mountains via the village of Kapıkaya to Elaia (Figure 5.1.21), for which the pavement is supposedly still preserved in some places today.[415] At the foothills of the Yund Dağı Mountains, the route passed the Hellenistic fortresses on Sakarkaya[416] and Gavur Evleri[417] as well as Zindan Kayası[418], which may have been used as a fortress in the Hellenistic period.

5.12. Route L Atarneus – Pergamon

5.12.1. Route L1 Atarneus – Pergamon

In antiquity, the route from Atarneus or present-day Dikili to Pergamon did not play a key role because the important harbors of Elaia and Pitane were located south of the Kara Dağı Mountains in the Gulf of

410 Rheidt 1986 supplementary sheet 6; Tozan 2017, 554.
411 Rheidt 1986; Tozan 2017.
412 Pirson 2019, 117–118 (B. Ludwig).
413 Pirson 2012b, 213–214 (M. Zimmermann); Pirson 2013, 121–123 (A. Matthaei).
414 Pirson 2020, 205–223 (B. Ludwig – Z. M. Aksan – F. Pirson).
415 Diest 1889, 27.
416 Pirson 2010, 201; Pirson 2011, 171–173.
417 Conze 1912, 114–115 (C. Schuchhardt); Pirson 2010, 200–201.
418 Pirson 2010, 201; Pirson 2012b, 222–225.

Çandarlı. Moreover, Atarneus was already flourishing in Hellenistic period and lost importance with the rise of Pergamon.[419]

In many historical maps, the connection between Atarneus or present-day Dikili and Pergamon is shown as the best developed road in the region and is therefore considered as a continuously important connection since antiquity. In fact, this road was only constructed by Carl Humann in the second half of the 19th century.[420] At this time, Dikili became increasingly important as the nearest harbor to Bergama. But even a milestone (MS 5) discovered at Ovacık does not give any indication of an ancient road or its course.[421]

Another specific aspect of this route is the condition of the landscape between the foothills of the Kozak and Kara Dağı Mountains. Southeast of Atarneus, there was a swampy area, which partly extended all the way to Kalarga Tepe (Teuthrania) (see study area). C. Humann had to build elaborate bridge constructions to cross this swamp, but due to their need of intensive maintenance, they collapsed after a few years.[422] It is therefore unlikely that a well-developed road already existed in antiquity. It is instead more probable

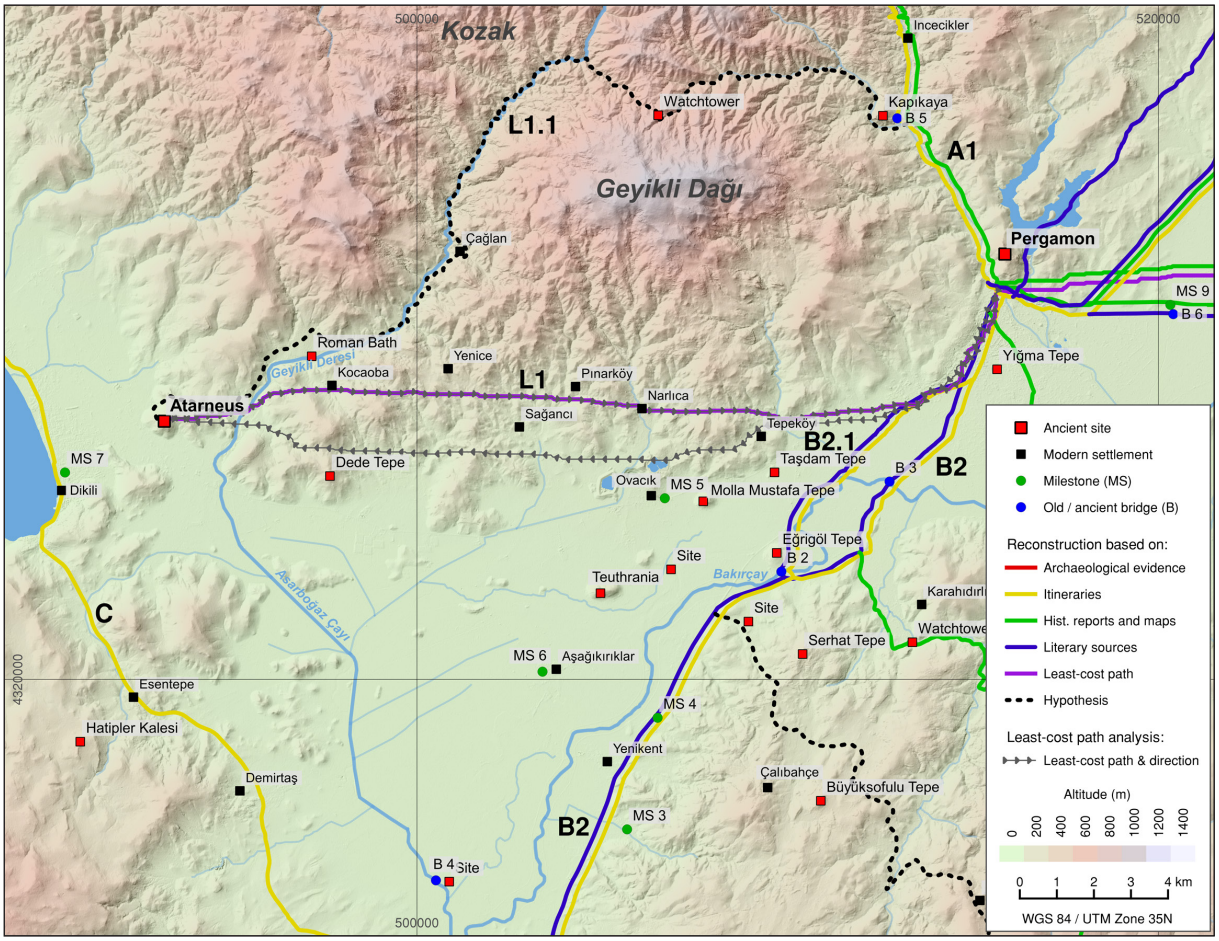

Fig. 5.1.23 Calculated least-cost paths and reconstructed routes between Atarneus and Pergamon.

419 Zimmermann et al. 2015.

420 Diest 1889, 9.

421 French 2014, 69.

422 Diest 1889, 9.

that a route between Atarneus and Pergamon existed along the slopes of the Kozak Mountains and the Geyikli Dağı, similar to the calculated least-cost paths (Figure 5.1.23). The most probable course follows the calculated least-cost path from Atarneus to Pergamon, which passes the present-day villages in the foothills of the Kozak Mountains and the Geyikli Dağı. In addition, there have been no settlements between Dikili, Ovacık and Aşağıkırıklar that needed to be made accessible by roads at least until the 19th century.[423]

5.12.1.1. Route L1.1 Atarneus – Pergamon (through the Kozak Mountains)

An alternative route from Atarneus to Pergamon may have led through the Kozak Mountains north of the Geyikli Dağı (Figure 5.1.23). The route ran through the Geyikli Dere, passing a Roman thermal bath and reaching the pass that led to the Kömür Dere. On the narrow ridge, a probably Byzantine watchtower controlled the pass between the two valleys.[424] Leaving the watchtower behind, the route continued via Kapıkaya to Pergamon.

5.13. Route M Pitane – Pergamon

Pitane played an important role for Pergamon's connection to supra-regional maritime trade networks, at least since the Roman Imperial period.[425] Due to its peninsular position, the city could only be reached by land from the north (Figure 5.1.24). It can be assumed that a route north of the Bakırçay River through the plain already existed in antiquity. Although the landscape of the plain has changed since antiquity (see study area), several archeological sites can be considered as evidence for such a route, such as bridge 4 over the Asarboğaz Çayı. Sections east and west of the bridge are paved with spolia today.[426] A site next to the bridge dating back to the Roman Imperial period underlines the continuity of this river crossing.[427] Moving onwards, the route runs south of Teuthrania where it meets the ancient main road leading down the southern slope of the prominent hill. A milestone (MS 6) found nearby at Aşağıkırıklar with Pergamon as starting point (*caput viae*) provides further evidence of a road in this area.[428] East of Teuthrania, the road passed a necropolis that is located on the southern slopes of the Sultantepe.[429] A few hundred meters further east, between the old arms of a river on a slightly elevated hilltop, a large building complex from the Hellenistic or Roman Imperial period is located.[430] Further on, the route passes the Taşdam Tepe, where the entrances of a tumulus and a rock chamber grave are oriented southeast towards the route.[431] Via the route mentioned in section B2.1, the road from Pitane finally led to Pergamon.

423 Kiepert 1890; Conze 1912, 35–42 (O. Berlet).

424 Conze 1912, 128 (C. Schuchhardt); Pirson 2019, 123 (B. Ludwig).

425 Ludwig 2022.

426 Pirson 2019, 124–125 (B. Ludwig).

427 Pirson 2019, 125 (B. Ludwig).

428 French 2014, 69–71.

429 Pirson 2020, 205–223 (B. Ludwig – Z. M. Aksan – F. Pirson).

430 Pirson 2012b, 216–217 (M. Zimmermann); Schneider et al. 2015; Pirson 2020, 205–223 (B. Ludwig – Z. M. Aksan – F. Pirson).

431 Pirson 2012b, 241–248 (V. Stappmanns).

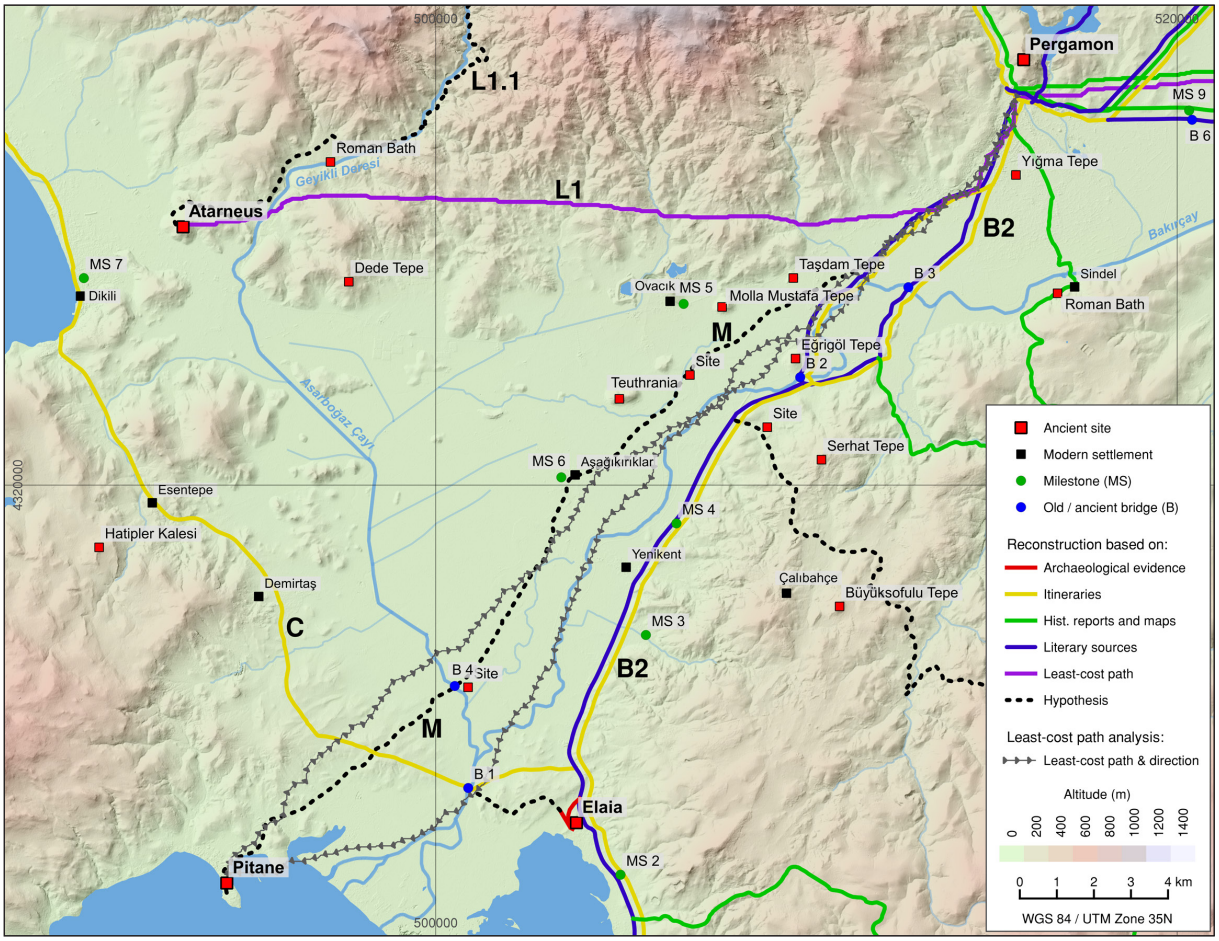

Fig. 5.1.24 Calculated least-cost paths and reconstructed route between Pitane and Pergamon.

The calculated least-cost path from Pergamon to Pitane runs near the already identified and discussed road between Pergamon and Elaia. The last section between bridge 1 and Pitane runs through an area that was below sea level in antiquity.[432] The calculated least-cost path from Pitane to Pergamon corresponds approximately to the reconstructed route.

5.14. Route N Kane – Coastal road (C Adramytteion – Elaia)

An ancient road between Kane and Atarneus is not very likely. The shoreline is extremely steep in this area and the construction of a road would have required much effort and resources. For a relatively small harbor city like Kane, waterborne transport was much more efficient than the construction of coastal roads. However, the harbor was by no means cut off from the road network of the region. A connection from Kane through the Kara Dağı Mountains, passing the fortress on the Kavaklık Tepe[433] and the settlement of Hatiplar Kalesi[434] and leading to the ancient coastal road (route C) can be assumed (Figure 5.1.25). The fortress on Kavaklık Tepe would have therefore served as an important observation point

432 Seeliger et al. 2013.

433 Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 212–213 (M. Zimmermann).

434 Pirson 2010, 181–182 (M. Zimmermann); Pirson 2011, 154–158 (M. Zimmermann); Pirson 2013, 119–121 (A. Matthaei).

for the security of the route and the largest known settlement in the northern Kara Dağı Mountains, Hatiplar Kalesi, and would have been well connected to both the harbor in Kane and the Bakırçay Valley.

5.15. Route O Kane – Kara Dağı Mountains

The only remains of an ancient extra-urban road that have been discovered so far are located in the northern Kara Dağı Mountains (Figure 5.1.25). The road led up into the Kara Dağı Mountains and connected Kane with the farmsteads of Asarlık Tepe[435] and Söğütlü Kalesi[436]. The southern part of the road consists of andesite field stones over a length of 1.1 km and has a width of between 1 m and 2.5 m. A second lane has been identified on the northern part of the road, and 1.5 km south of Bademli another paved road branches off to the north-east.

Whether the road from Söğütlü Kalesi continues to the watchtower at Denizköy[437] or even to Pitane, as reconstructed by Tozan[438], is uncertain, since the terrain in this part of the peninsula is very rugged. The road instead served as a connection between the fertile plateaus and the farmsteads of the Kara Dağı Mountains and the harbor of Kane.

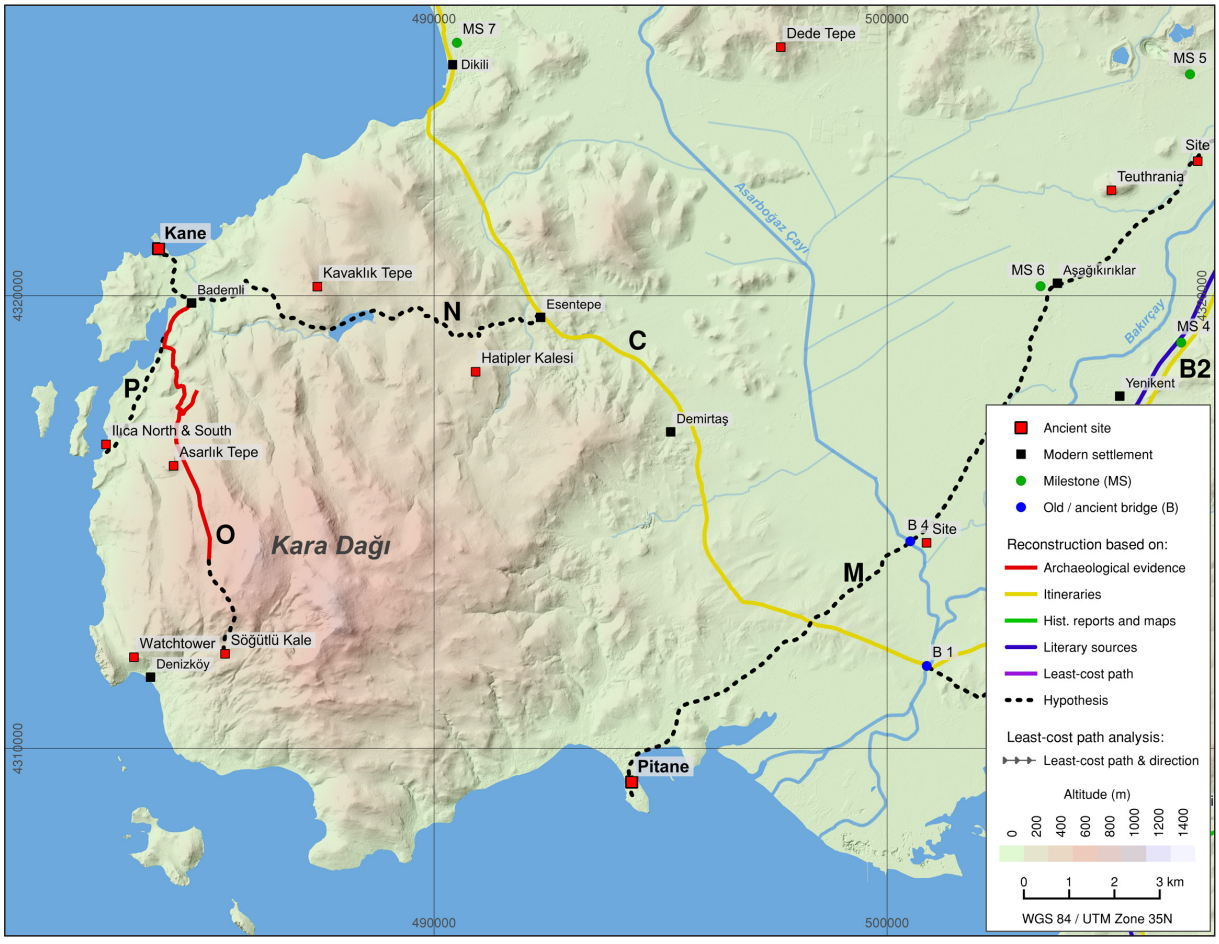

Fig. 5.1.25 Reconstructed routes between Kane and the ancient coastal road and from Kane to the Kara Dağı Mountains.

435 Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 212 (M. Zimmermann).

436 Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 211–212 (M. Zimmermann).

437 Pirson 2018, 161–164 (S. Feuser – E. Laufer).

438 Tozan 2017.

5.16. Route P Kane – Ilıca North and Ilıca South

Thermal baths (Ilıca North and Ilıca South) dating back to the Roman Imperial period can be found along the shore south of Kane (Figure 5.1.25).[439] It can be assumed that they had moorings for transporting people and goods to the nearby larger harbors of Kane, Pitane or Elaia. An additional 4.5 km long land route to Kane also cannot be excluded. The terrain along the coast is relatively flat and such a route not only may have connected the thermal baths but also the bays and landing sites near the Arginusae Islands with Kane.[440]

5.17. Route Q Perperene – Coastal road (near Ayvalık)

From Perperene in the Kozak Mountains, at least two other routes led to the ancient coastal road (route C). One connection was recently reconstructed by M. Tozan along today's Bergama-Ayvalık road to the coast (Figure 5.1.26).[441]

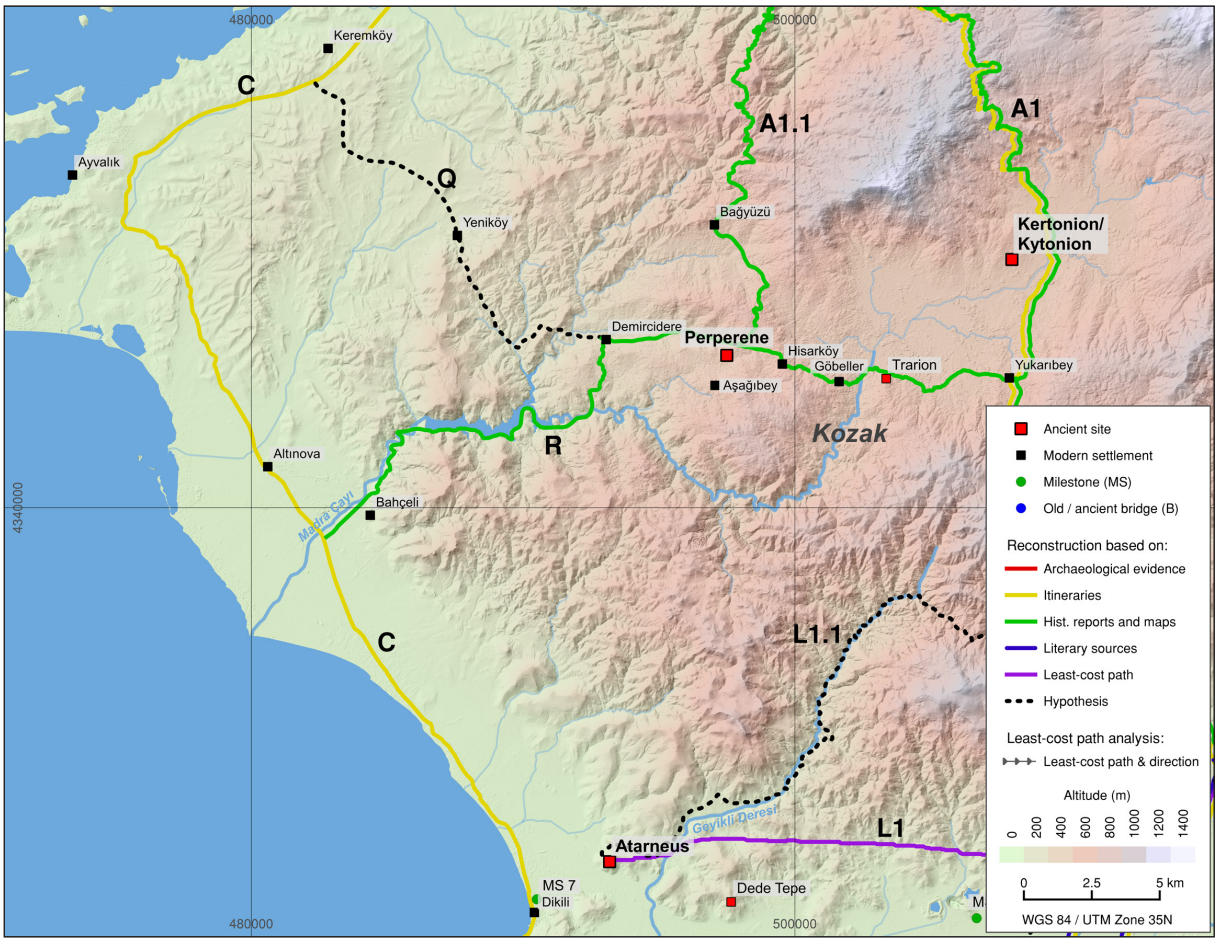

Fig. 5.1.26 Reconstructed routes between Perperene and the ancient coastal road.

439 Pirson 2015, 146–150 (E. Laufer); Pirson 2016, 178–179 (E. Laufer); Pirson 2018, 164–167 (S. Feuser – E. Laufer).

440 Pirson 2016, 177–178 (E. Laufer).

441 Tozan 2017, 563.

5.18. Route R Perperene – Coastal road (near Altınova)

Another route probably ran to the coast near present-day Altınova (Figure 5.1.26). It was recently reconstructed by K. Rheidt along with a Byzantine fortress near Bahçeli.[442] It is mentioned by W. von Diest as a 'summer path', as it led through the riverbed of the Madra River at numerous places.[443]

5.19. Route S Kozak Mountains and Kestel Creek Valley – Pergamon

Another route must have led from the Kozak Mountains through the Kestel Creek Valley (Ketios Valley) to Pergamon (Figure 5.1.27). Due to the present-day reservoir north of the city hill, any remains of a route are likely lost in this area. A watchtower on the Çoban Tepe[444] next to the river is strong evidence for the existence of route through the valley, however. From this place the valley could be observed and controlled very well. Another site is located 5 km north-east of Çoban Tepe near Avunduruk. It offered an outstanding view of the Kestel Creek Valley up to Pergamon and into the Kozak Mountains, serving as an observation post as well (Figure 5.1.28).

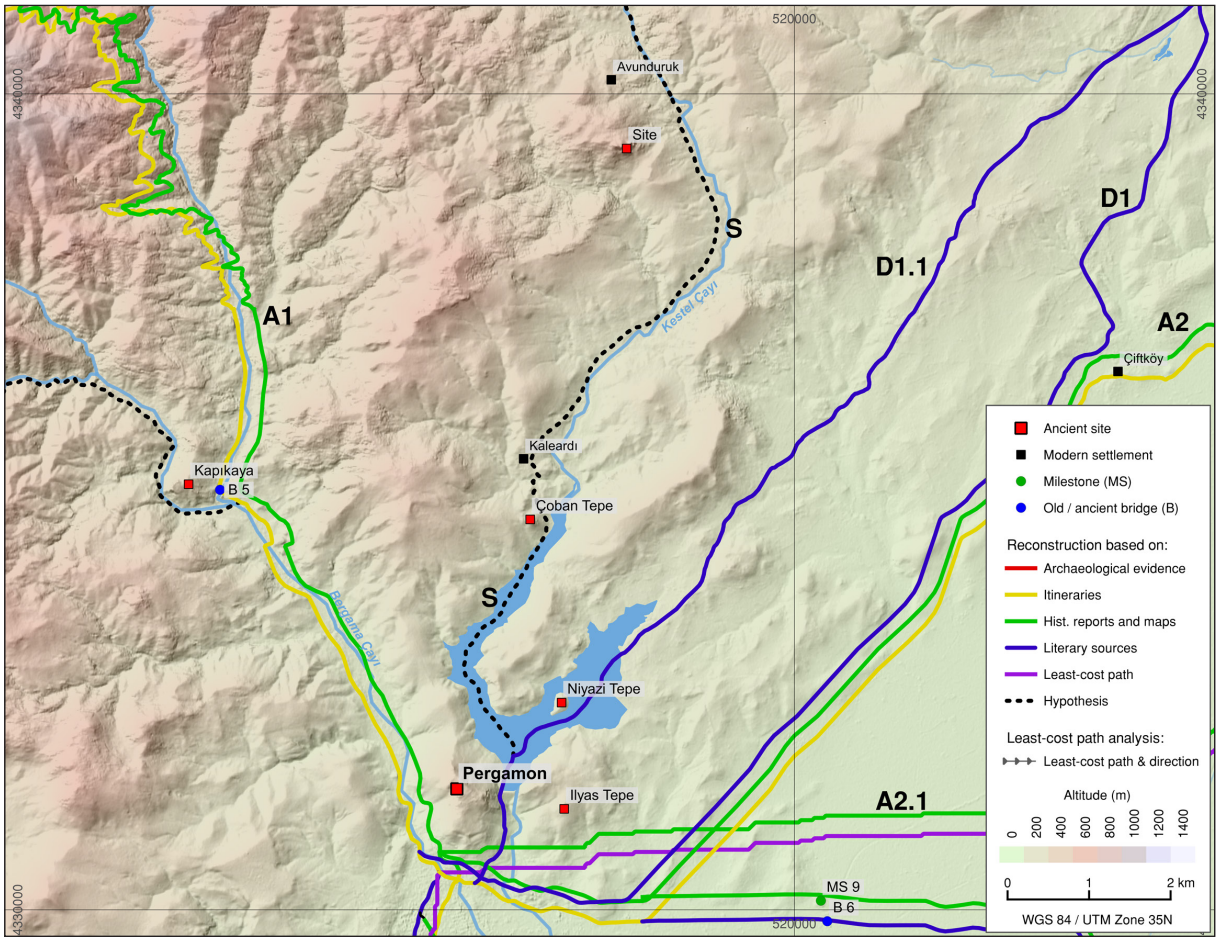

Fig. 5.1.27 Reconstructed route from Pergamon through the Kestel Creek Valley into the Kozak Mountains.

442 Rheidt 1986 supplementary sheet 6.

443 Diest 1889, 12.

444 Conze 1912, 128–129 (C. Schuchhardt).

Fig. 5.1.28 View from the site near Avunduruk to the south.

6. Discussion

The routes reconstructed in this study connect the city of Pergamon with its surrounding mountain ranges, the Bakırçay Valley and the Aegean coastline. The compilation of all routes provides a general overview of the route network for the first time (Figure 5.1.29, Table 5.1.4), which can now be discussed in different contexts. Even though this route network does not claim to be complete, since, for example, smaller secondary routes and some supra-regional connections to settlements at a greater distance from Pergamon could not be considered, important aspects can be derived from this network.

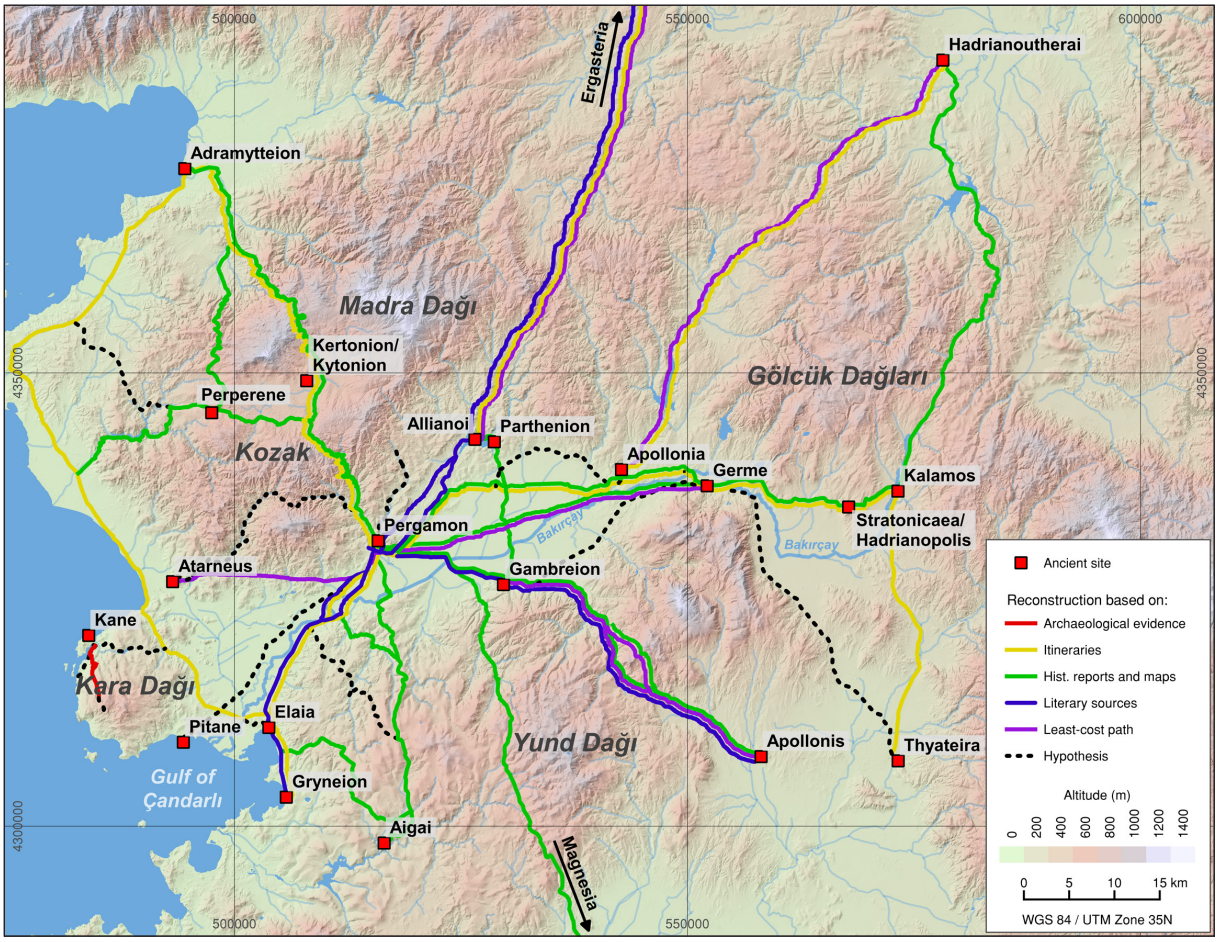

Fig. 5.1.29 Reconstructed route network in Pergamon's surroundings.

Table 5.1.4 Reconstructed routes with their code and distance.

Code	Route	Distance (in km)
A	**Adramytteion – Thyateira**	**152.42–176.14** [1]
A1	Adramytteion – Pergamon (via Kytonion)	71.17
A1.1	Adramytteion – Pergamon (via Perperene)	75.98
A2	Pergamon – Germe (via Apollonia)	41.75
A2.1	Pergamon – Germe (through the plain)	40.85
A2.2	Pergamon – Germe (along the northern edge of the eastern lower Bakırçay Valley)	44.80
A2.3	Pergamon – Germe (along the southern edge of the eastern lower Bakırçay Valley)	41.35
A3	Germe – Thyateira (via Stratonicaea/Hadrianopolis and Kalamos)	55.36
A3.1	Germe – Thyateira (via Kirkağaç)	40.40
B	**(Ephesus –) Gryneion – Pergamon (via Elaia)**	**54.51–54.52** [1]
B1	Gryneion – Elaia and around Elaia	29.88
B2	Elaia – Pergamon (via bridge 3)	24.64
B2.1	Elaia – Pergamon (via bridge 2)	24.63
C	**Adramytteion – Elaia**	**82.30**
D	**(Cyzicus –) Ergasteria – Pergamon**	**87.65–89.62** [1]
D1	Ergasteria – Pergamon (via Parthenion and Allianoi through the Bakırçay Valley)	89.62
D1.1	Ergasteria – Pergamon (via Parthenion and Allianoi through the Kestel Valley)	87.65
E	**Hadrianoutherai – Pergamon**	**104.10**
E1	Hadrianoutherai – Apollonia	70.70
E2	Apollonia – Pergamon (=A2 in parts)	33.40
F	**Hadrianoutherai – Thyateira**	**91.30**
F1	Hadrianoutherai – Kalamos	60.41
F2	Kalamos – Thyateira (A3 in parts)	30.89
G	**(Sardis –) Apollonis – Pergamon**	**58.73**
G1	Apollonis – Gambreion	42.71
G2	Gambreion – Pergamon	16.02
H	**Parthenion – Gambreion**	**19.89**
I	**Magnesia – Pergamon**	**69.03**
J	**Aigai – Pergamon**	**40.69–48.47** [1]
J1	Aigai – Pergamon	43.97
J1.1	Aigai – Pergamon (eastern route)	40.69
J1.2	Aigai – Pergamon (western route)	48.47
K	**Aigai – Coastal road (Elaia)**	**28.94**
L	**Atarneus – Pergamon**	**25.90–38.12** [1]
L1	Atarneus – Pergamon	25.90
L1.1	Atarneus – Pergamon (through the Kozak Mountains)	38.12
M	**Pitane – Pergamon**	**32.39**
N	**Kane – Coastal road (C Adramytteion – Elaia)**	**10.88**
O	**Kane – Kara Dağı Mountains**	**14.67**
P	**Kane – Ilıca North and Ilıca South**	**8.90**
Q	**Perperene – Coastal road (near Ayvalık)**	**22.32**
R	**Perperene – Coastal road (near Altınova)**	**22.64**
S	**Kozak Mountains and Kestel Creek Valley – Pergamon**	**13.18**

[1] Shortest and longest distance.

6.1. Route Network as Element of Socio-Economic Processes

A city like Pergamon was dependent on the food supply from its rural surroundings. The extent to which the Pergamon Micro-Region was able to supply the city or whether additional imports were necessary is the subject of current discussions.[445] It can be assumed, however, that the lower Bakırçay Valley and the adjacent slopes and valleys, whose fertility was already praised by Strabo[446], ensured a large part of the food supply. They were made accessible by the east-west connections through the lower Bakırçay Valley. The route to Elaia (route B2, B2.1) or the routes to Pitane (route M) and Atarneus (route L) connected the western lower Bakırçay Valley with its scattered agricultural and rural settlements, which existed during the Hellenistic period and probably continued during the Roman Imperial period.[447] The same can be assumed for the eastern lower Bakırçay Valley with the routes to Parthenion and Allianoi (route D1, D1.1), Apollonia (route A2, A2.1, A2.2, E2) and Gambreion (route G2).

Other goods such as timber and firewood or stones such as granite and marble were mainly carried from the Kozak Mountains to Pergamon.[448] The main traffic routes for such resources were the connections to Perperene (route A1.1) and Kytonion (route A1), and through the Kestel Creek Valley (route S). Imports from more distant regions could be transported to Pergamon via the routes from Adramytteion (route A1, A1.1), Ergasteria (route D), Hadrianoutherai (route E), Thyateira (route A2, A2.1, A2.2, A3, A3.1), Apollonis (route G), Magnesia (route I) or Aigai (route J).

Due to cheaper sea transport and the easier and safer route through the western lower Bakırçay Valley, a large amount of the supra-regional trade and transport is supposed to have been carried out via the harbors of Elaia and Pitane.[449] Elaia, as the main harbor of Pergamon, had the advantage of the shortest land connection to city. But at least since the Roman Imperial period, Pitane, which is only a few kilometers away from Elaia, became even more important for Pergamon due to the extension of its harbor. The two routes through the western lower Bakırçay Valley (Elaia: route B2, B2.1; Pitane: route M) are thus probably among the most important roads for the city.

6.2. Route Network as Element of Cultural Processes

Cult places such as tumuli or natural sanctuaries can be described as landmarks and their positioning is part of a spatial strategy during the Attalid rule.[450] Even though the mythical-religious topography of the surrounding countryside changed during the Roman Imperial period, these prominent structures remained and continued to form an impressive overture for people using the routes through the western lower Bakırçay Valley to Pergamon.[451]

The monumental buildings on the city hill, such as the Trajaneum, the Great Altar, or the Athena sanctuary are deliberately oriented to the southwest and thus create visual connections to the western

445 Sommerey 2008; Knitter et al. (in press).

446 Strabo 13, 4, 2; Jones 1917–1932.

447 Sommerey 2008, 155–159.

448 Radt 1997; Pirson 2008a, 44–45; Sommerey 2008, 164.

449 Ludwig 2022.

450 Pirson – Ludwig (in press).

451 Pirson 2008a, 36; Pirson – Ludwig (in press).

lower Bakırçay Valley.[452] This architectural layout is therefore particularly impressive when arriving via the routes from Elaia and Pitane (route B2, B2.1 and M). These examples illustrate that the course of routes and the placement of monuments along them have also been used as a means of demonstrating power.

Visual connections between Pergamon and extra-urban natural sanctuaries such as Kapıkaya or Mamurt Kale have already been proven.[453] They can now be supplemented by the routes reconstructed here and create new perspectives for the investigation of the relation between the city and extra-urban natural sanctuaries.

The connection to other suburban facilities such as the Roman thermal bath Kleopatra Güzellik Ilıcası[454] or the Asklepieion on the outskirts of present-day Bergama must remain the subject of future investigations in the context of the urban street system.

6.3. Control and Securing of the Route Network

The reconstructed routes in the region surrounding Pergamon represent the lifelines of the city. They ensured the supply of the city with resources and food, and enabled regional and supra-regional exchange of information, goods, and people. It was therefore vital for Pergamon to control and secure these routes and the regions they accessed. Although numerous fortresses and fortified settlements in Pergamon's surroundings are known from the Hellenistic period, the function of most sites has not yet been analyzed. By reconstructing the route network, the function of many places now becomes particularly clear. All routes leading into the lower Bakırçay Valley passed a fortress or fortified settlement, which guaranteed control and protection (Figure 5.1.30).

The Hellenistic fortress on Eğrigöl Tepe, which is identified with ancient Halisarna, was located about 10 km southwest of Pergamon. Directly next to the hill passed the route to Pitane, and the route to Elaia crossed the Bakırçay River nearby as well (bridge 1). Due to its location, the site served as an important landmark[455] and at the same time controlled the traffic routes in the western lower Bakırçay.[456]

Only 3 km east of Eğrigöl Tepe, the Değirmendere opens into the Bakırçay Valley. One of the main routes from the Yund Dağı Mountains ran through this valley, leading from Aigai to Pergamon (route J). Close to the end of the valley and 1 km southwest of Karahıdırlı, a Hellenistic watchtower was situated on a hill above the route.[457] This watchtower controlled the entrance from the Yund Dağı Mountains in the Hellenistic period. In the Roman Imperial period, this role was probably taken over by a nearby fortress.[458]

The western route from Aigai to Pergamon (route J1.2) led through a fertile basin and open valleys into the Bakırçay Valley. This area and the route were controlled by two fortresses dating back to the

452 Cf. Pirson – Ludwig (in press) with further literature.

453 Williamson 2014a.

454 Pirson 2019, 94–105 (S. Feuser – K. Piesker – E. Erkul).

455 Pirson 2008a, 37–38.

456 Conze 1912, 116–117 (C. Schuchhardt); Pirson 2008a, 34.

457 Pirson 2018, 167–168 (B. Ludwig – F. Pirson).

458 Diest 1889, 28; Conze 1912, 117 (C. Schuchhardt).

Hellenistic period. From a fortress on the Büyüksofulu Tepe[459], large parts of the route could be observed (Figure 5.1.22). The site also provided line-of-sight connections across the Bakırçay Valley to Pergamon and to the fortress on Serhat Tepe[460]. This place offered an extraordinary view into the Bakırçay Valley, to Pergamon, and over the foothills of the Yund Dağı Mountains, whose routes could be controlled from here.

Southeast of Elaia, another route from the Yund Dağı Mountains led to the coastal road. This route was controlled by the fortresses on the Sakarkaya[461] and the Gavur Evleri[462], both of which were used during the Hellenistic period. Elaia, which was located at the bottleneck between the foothills of the Yund Dağı Mountains and the coast (Figure 5.1.10), also served as a checkpoint at the southwestern entrance to the lower Bakırçay Valley.[463]

The routes from the harbors and landing sites along the Kara Dağı Mountains were also controlled by watchtowers.[464] In this context, the fortress on the Kavaklık Tepe[465] in the northern Kara Dağı Mountains, which could observe and secure the route to Kane (route N), should be highlighted.

The northwestern entrance to the lower Bakırçay Valley could be secured by Atarneus (Figure 5.1.13) or the fortress on the Dede Tepe.

The important routes from Perperene and Adramytteion (route A1, A1.1) to Pergamon must have been secured as well. Although W. von Diest describes Kapıkaya as a watchtower that would actually be predestined for this purpose, this place primarily had a ritual function.[466] For the routes from the western Kozak Mountains, Perperene was considered the primary fortress.[467] The same function was fulfilled by Kytonion for the western route from Adramytteion to Pergamon.[468]

Near Kaleardı, about 4 km northeast of Pergamon, a watchtower was located on the small Çoban Tepe.[469] From this location, the road leading through the Kestel Creek Valley to Pergamon (route S) could be well controlled. In addition, 5 km northeast of Çoban Tepe, above the western bank of the Kestel Creek, another site offered a view over the entire valley up to Pergamon.

The routes that led to Pergamon via the eastern lower Bakırçay Valley were secured at the entrance to the plain by larger settlements such as Parthenion, Apollonia, Germe and Gambreion. A Byzantine fortress located in the valley southwest of Gambreion controlled the route through the Yund Dağı Mountains.[470]

459 Pirson 2019, 117–118 (B. Ludwig).
460 Pirson 2012b, 213–214 (M. Zimmermann).
461 Pirson 2010, 201; Pirson 2011, 171–173.
462 Conze 1912, 114 (C. Schuchhardt); Pirson 2010, 166–167. 200–201.
463 Pirson 2014; Seeliger et al. 2019.
464 Conze 1912, 100–101 (C. Schuchhardt).
465 Schuchhardt 1887; Conze 1912, 119 (C. Schuchhardt).
466 Diest 1889, 9; Nohlen – Radt 1978.
467 Fabricius 1886; Pirson 2008a, 44–45.
468 Fabricius 1886, 13–14; Conze 1912, 124 (C. Schuchhardt).
469 Conze 1912, 128–129 (C. Schuchhardt).
470 Diest 1889, 15; Conze 1912, 130–131 (C. Schuchhardt); Rheidt 1986, 231–232.

Whether previous buildings from the Roman Imperial period or Hellenistic period exist at this site has yet to be analyzed.

As a concluding remark, it can be stated that all routes leading to the lower Bakırçay Valley and thus to the core territory of Pergamon were controlled and secured by fortifications or fortified settlements in the Hellenistic period. In the Roman Imperial period this situation seems to have changed during which time several sites were abandoned.[471] Whether the fortifications or fortified settlements were part of a superordinate network, e.g., on the basis of mutual visibility, and what role they played for Pergamon in securing the routes and territory in the Hellenistic and Roman Imperial period should be investigated more specifically in future studies.

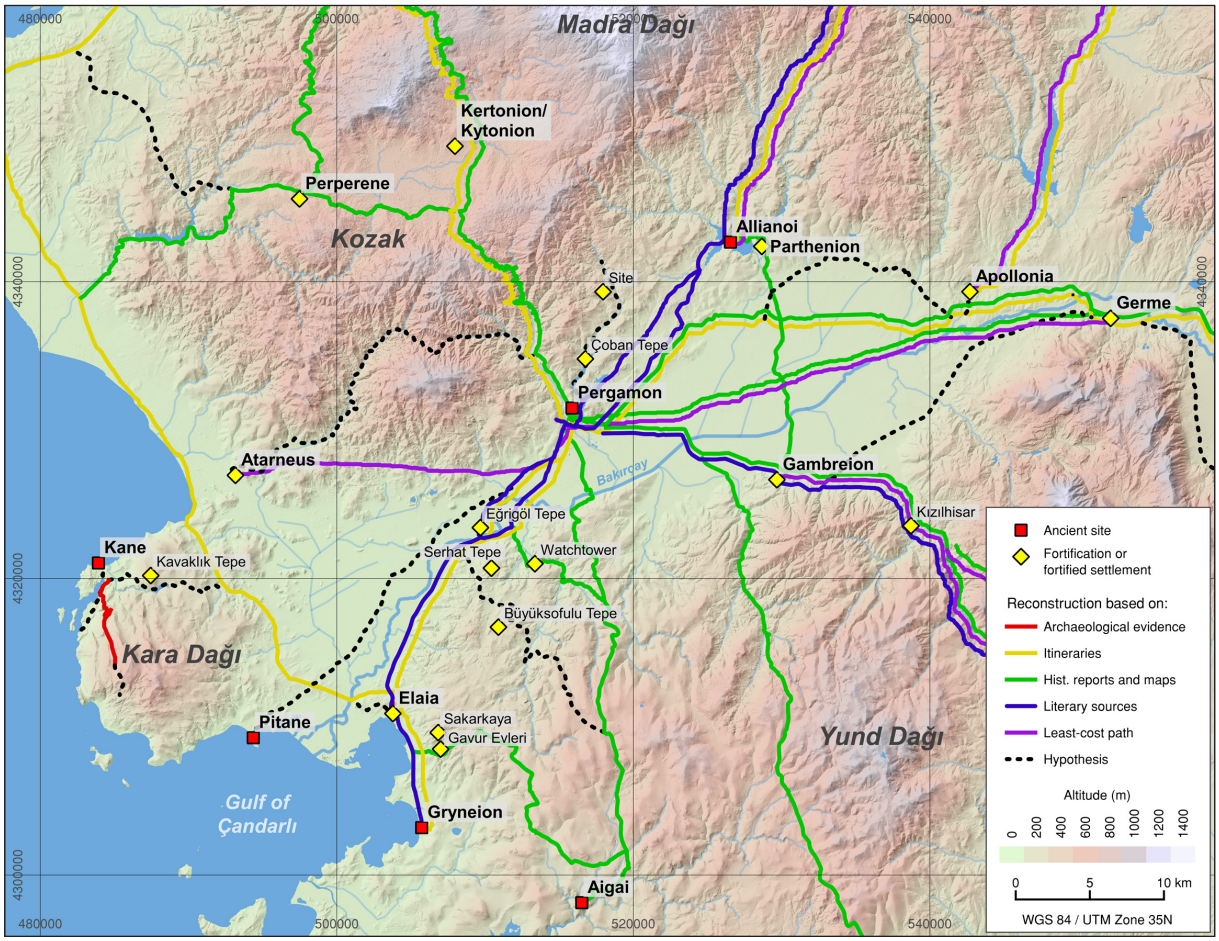

Fig. 5.1.30 Reconstructed route network in the surroundings of Pergamon. The yellow squares represent fortifications or fortified settlements.

471 Cf. Pirson 2017, 113.

7. Conclusions

The aim of this study was the reconstruction of the ancient route network in the region surrounding Pergamon by combining historical and archeological sources with modern computer-aided least-cost path analyses. Despite the limited number of archeologically known ancient roads or other infrastructural elements in the vicinity of Pergamon, this study has succeeded in drawing a comprehensive overview of the ancient route network in the region. The great importance of a well-developed route network for the development and prosperity of a city like Pergamon becomes obvious. The routes enabled not only regional and supra-regional trade but also communication and the supply of food and resources. In addition, they facilitated military movements and essential routes were controlled and secured by the construction of specific fortifications in the Hellenistic period. Many aspects of social life are therefore based on the use of these routes.

The study of routes in the surroundings of Pergamon cannot yet be considered complete. Nevertheless, the results already offer new perspectives in the investigation of the relationship between the ancient city of Pergamon and its surrounding landscape and they provide new opportunities for the study of human-environment relations within the Pergamon Micro-Region.

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5.2 Pergamon's Access to the Sea. Analysis of its Landing Sites with a Focus on Connectivity and Visibility

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(own contribution: 100 %)

Abstract

Due to Pergamon's location, about 20 km inland, access to the sea played a vital and decisive role in the development and success of Pergamon and its micro-region. It was generally assumed that the Pergamene rulers ensured this access by installing and controlling harbors such as Elaia along the coastline. In this context, the question arises as to which other coastal places were important for Pergamon in supplying the micro-region, transporting people and goods and exchanging information. The aim of this paper is to discuss different types of landing sites: harbors, ports, opportunistic ports and *villae maritimae*, showing their functional diversity as well as their structural hierarchy. Furthermore, the paper analyzes aspects of connectivity between the Pergamon Micro-Region and the various coastal places and aims to interpret the maritime façade as an element of dynamic interaction in a diachronic perspective. Although the archaeological record of landing sites along the coast is difficult to trace or has been entirely destroyed by natural or anthropogenic factors, established digital tools such as visibility analysis or least-cost path analysis allow conclusions to be drawn about the function of ancient landing sites and their relationship to Pergamon and the micro-region in terms of economy, communication and participation in naval warfare. The results show, that access to the sea remained vital for the remote metropolis of Pergamon and its micro-region over centuries, but while military aspects were a major concern in the Hellenistic period, trade and leisure became increasingly important during the Roman Imperial period. The three major harbor cities Elaia, Kane and Pitane and several smaller landing sites on the Pergamene coastline reflect these changing needs and provide essential evidence of the networks and dynamic spaces of interaction within the Pergamon Micro-Region.

Keywords: Harbor, Interaction, Landing Site, Least-cost Path Analysis, Pergamon Micro-Region, Villa Maritima, Visibility Analysis

1. Introduction

Pergamon, one of the major urban centers of Asia Minor, was characterized by its location on a steep hill in the middle of a remote valley. The city had with no direct access to the sea or the main land routes leading from the Aegean to the Anatolian plain and further east. It is generally assumed that this situation placed the city at an economic disadvantage in the Roman Imperial period compared to coastal cities such as Ephesus and Smyrna, although this location provided more security in the warlike Hellenistic period, during which the city had a greater need for defense as royal seat.[472]

On a regional level, the geographical position of Pergamon facilitated control over the lower Kaikos Valley and the adjacent mountain ranges (Fig. 5.2.1). In the Hellenistic period, the extension or reduction of cities under Attalid rule, the erection of fortified settlements and military forts, the promotion of rural sanctuaries, and the placement of visually significant grave-monuments attest to the dominance the city of Pergamon had over its territory, which was much larger than the *chora* of a single city. These elements of control were connected within a visual network that also served as a bearer of Attalid dynastic ideology.[473]

On a more general level, the area outlined above can be described as a micro-region. Micro-regions are not primarily geographical entities, but rather dynamic spaces of interaction between humans and the natural environment. They are characterized by individual cultural specifications and their own cycles of production and consumption, which can be incorporated in broader networks of exchange.[474] In terms of economy as well as communication and participation in naval warfare, access to the sea was vital for the Pergamon Micro-Region, particularly when it was the nucleus of a Hellenistic territorial state.

This access had to be ensured via specific places along the coast that could be reached efficiently from the city of Pergamon and the wider micro-region. Furthermore, these spaces offered opportunities and facilities for the transshipment of people and goods within regional and supra-regional maritime trade networks. This paper analyzes aspects of connectivity between the Pergamon Micro-Region and its coastal places. Various landing sites along the coastline will be discussed according to functional diversity as well as to structural hierarchy. The research is supported by the results of spatial analyses, such as viewshed or least-cost path analyses.

1.1 The coastline of the Pergamon Micro-Region

Pergamon's access to the sea was facilitated by a coastline of approximately 45 km, stretching between Elaia (Zeytindağ), the main port of Pergamon in the Gulf of Çandarlı (Çandarlı Körfez), in the south and the present-day city of Dikili in the north. The remains of two other ancient harbors Pitane (Çandarlı) and Kane (Bademli) are located between the terminal points. The coastline is characterized by a steep coast with striking cliffs and a multitude of smaller peninsulas and bays and is dominated by the 750 m high mountain Kara Dağ, the highest mountain on the Kane Peninsula. Southwest of Kane are the Arginusae Islands (Garip Adaları), which belonged to the *chora* of the city of Kane (Strabo 12, 1, 68) and

472 See for instance Radt 2016, 17–20.

473 See Pirson 2008a; Pirson 2012a, 219–229; Pirson – Zimmermann 2014; Pirson 2017, 92–95; Pirson – Ludwig (in press).

474 Cf. Zimmermann 2015a, 403–405.

Fig. 5.2.1 Western part of the Pergamon Micro-Region and its coastline

are mentioned in the context of the Peloponnesian War as a naval base and the scene of a naval battle in 406 BCE (Thucydides 8, 101, 2; Xenophon, Hellenica 1, 26, 27–34; Diodorus 13, 97–99). Only 15 km further west, the island of Lesbos rises out of the sea. Southwest of the Kane Peninsula lies the island Mardalıç Adası, or Hagios Georgios, which is identified by J. Stauber as ancient Elaioussa.[475] The remains of a *villa maritima*, probably dating from the late 1st century to the 1st half of the 2nd century CE, can be found on the island.[476]

Access to this stretch of coastline was of central importance for the development and success of Pergamon. The harbors and landing sites along the coast extended spheres of influence into the hinterland and existed as liminal zones between land and sea. This catchment area offered economic, social, political or military connections to other (micro)regions.

475 Stauber 1996, 288–289.

476 Hoffmann 1993; Pirson 2017, 113 Fig. 53. 54.

Like all coastal regions, the one described here is subject to constant change due to natural factors such as wind and waves.[477] In addition, the coastal region and its archaeological sites are threatened by modern anthropogenic influences such as the construction of numerous new residential and holiday settlements. Nevertheless, significant discoveries have been made between 2006 and 2018 within the scope of two interdisciplinary research projects of the Pergamon Excavation Project of the German Archaeological Institute (DAI) on Elaia and the Kane Peninsula.[478] This paper is based on these results.

1.2 Objectives and Methods

In the context of Pergamon's access to the sea, the questions arise as to which coastal places were important for Pergamon in supplying the micro-region, transporting people and goods and exchanging information? Can military or economic relevance be read from specific coastal spaces, and is a hierarchy of their function and importance identifiable?

It has generally been assumed that the Pergamene rulers ensured access to supra-regional trade and communication networks by controlling harbors from the capital in the hinterland. Elaia is considered the main port of Pergamon and the naval base of the Attalids.[479] But it is obvious that the supply of the micro-region was not exclusively carried out through Elaia. Hence the Kane Regional Harbour Survey had been conceptualized in addition to the Elaia-project with the aim to provide a complete image of the maritime façade of the Pergamon Micro-Region and its function as a network of communication and exchange. In this context, spaces all along the coast will be analyzed likewise in the following sections. In order to clearly present the coastline with its spaces important for Pergamon and its micro-region, the terms 'landing site', 'harbor', 'port' and '*villa maritima*' should first be differentiated. Using these functional categories, the probable use of the sites can then be discussed with more precision.

When analyzing the function of a site in the context of networks and the surrounding landscape, accessibility, i.e., the location and distance to neighboring sites, plays an important role. Accessibility can be defined as a "measure of the capacity of a location to be reached by, or to reach different locations".[480] In order to assess the most efficient connections between geographic positions, in this case Pergamon and the coast, least-cost path analyses were carried out.[481] Such analyses are generally used to identify probable routes between two known locations on the basis of the terrain. In addition, assumptions can

477 See Seeliger et al. 2013; Seeliger et al. 2019.

478 The project 'Elaia: Eine aiolische Polis als Subzentrum der hellenistischen Metropole Pergamon' (2006–2012) was funded within DFG-Schwerpunktprogramm 1209 'Die hellenistische Polis'; see Pirson et al. 2015; Feuser et al. 2018. The project 'The Maritime Topography of the Ancient Kane Peninsula: A Micro-Regional Approach to the Impact of Harbours and Anchorages on Politics, Economy and Communication of a Western Anatolian Landscape. Kane Regional Harbour Survey (KRHS) 2014–2018' was part of 'Portus Limen – Rome's Mediterranean Ports' project, financed by the European Research Council (European Union's Seventh Framework Program FP7/2007–2013); see Pirson 2015, 146–150 (E. Laufer); Pirson 2016, 174–185 (E. Laufer), 185–190 (M. Seeliger – A. Pint – M. Herbrecht – H. Brückner); Pirson 2018, 150–167 (S. Feuser – E. Laufer). Both projects have been directed by F. Pirson (DAI Istanbul) in cooperation with H. Brückner (Universität Köln) and W. Rabbel (CAU Kiel).

479 Pirson 2004; Pirson 2014.

480 Rodrigue et al. 2006.

481 The least-cost paths are calculated with r.slope and r.walk in QGIS on the basis of the EU-DEM v1.1. This elevation data is provided by the EU Copernicus project for free with a pixel resolution of 25 by 25 meters and a vertical accuracy of 7 meters. See Copernicus Programme 2022b.

be made about the type of movement or the ease of travel.[482] In this study, least-cost path analysis is only intended to compare distances and thus travel times.[483] On this basis, the advantages and disadvantages of the landing sites in relation to Pergamon become clearer.

Landing sites are never isolated phenomena, but always parts of economic, social or political micro-regions, whose interconnectivity are facilitated by sea lanes. According to P. Horden and N. Purcell, these sea lanes follow visual connections to islands or prominent topographical features along the coast.[484] Along the coast of the Pergamon Micro-Region, the Sakarkaya rock, the island Elaioussa or the Kara Dağ Mountain, the highest peak of the Kane Peninsula, are examples of prominent topographical features. In addition to local coastal shipping, which was conducted with continuous visual connection with the land, it can also be assumed that the seafarers involved in long-distance trade were guided by the topographical features of the micro-region's coast. In order to evaluate the role of visibility in relation to landing sites, visibility analyses were subsequently carried out.[485]

1.3 Terminology of landing sites

In many publications on ancient harbors or ports, all archaeological remains related to water, i.e., the sea or a river, are often subsumed under the terms 'harbor' or 'port'. However, this rarely reflects the function of the sites. Because of this generalization, the functional differences of the sites easily disappear. To avoid this problem, Kristin Ilves introduced the 'landing site-concept'. Accordingly, landing sites are "created and used for launching and/or reaching land with different kinds of watercraft and for activities associated with these seaward-landward activities".[486] This definition eliminates all preconceptions about the function of a site. In this paper, 'landing site' is used as a generic term for all sites along the coast or when the function of a site cannot be definitively clarified.

Landing sites often have no or only very simplistic maritime structures and are therefore difficult to prove in the archaeological record. Justin Leidwanger classifies such sites, which also operate largely independently of large port cities, as 'opportunistic ports'.[487]

If there are still ancient architectural remains in the shallow water, then these are most often the remains of moles. They separate an area of the coast in which ships can anchor or land protected from storms and waves, and thus form a harbor. In addition, a port can be part of a harbor and can be defined as a "harbor area in which are located marine terminal facilities for transferring cargo between ships and land transportation".[488]

In this context, also *villae maritimae* have to be considered as a special form of landing site. These are villas that have been built directly by the water, and in contrast to the agrarian *villae rusticae*, the

482 See Conolly – Lake 2006; Herzog 2008.

483 For the speeds of horses, walkers and oxcarts in antiquity, see Kolb 2000.

484 Horden – Purcell 2000, 124–143.

485 Visual analyses are calculated with r.viewshed in QGIS on the basis of the TanDEM-X elevation model (12 by 12 meters pixel resolution) with an observer offset height of 5 meters unless otherwise noted. The elevation model is provided by Deutsches Zentrum für Luft- und Raumfahrt (DLR) 2020.

486 Ilves 2012, 15.

487 Leidwanger 2013.

488 Rodrigue et al. 2006, 270.

luxurious *villae maritimae* had a more residential character for the Roman upper class and served the purpose of *otium* or 'wellness'.[489]

Landing sites along the coast of the Pergamon Micro-Region can be differentiated into harbors, ports, opportunistic ports and *villae maritimae*:

1) There are three major harbor cities: Elaia (Zeytindağ), Pitane (Çandarlı), and Kane (Bademli) (Fig. 5.2.1). They offer harbors, with moles separating parts of the coast or bay from the sea, but also ports, as they provide quay walls for loading and unloading people and cargo.

2) Opportunistic ports are often located in bays without a corresponding harbor town in the area, and are often difficult to prove in the archaeological record. But in the immediate vicinity of the bay of Bademli Liman, ceramic scatters have been found indicating an ancient use of the small bay (Fig. 5.2.1). The two sites Kemikliburun and Fundstelle 2017/05 are each located directly above a bay with a dominant view and a short distance to the sea (Fig. 5.2.1). Therefore, a connection between the sites and bays can be assumed. In the bays of Hayıtlı Liman and Piri Reis Sitesi, despite current surveys, no evidence of ancient use has been found so far (Fig. 5.2.1). This should not conclusively exclude this type of site from consideration, which is why they are taken into account in this paper.

3) Ancient structures made of stone blocks and *opus caementitium* have been documented by recent surveys along on the coast as parts of *villa marittimae*: these include the *villae* on Elaioussa (Mardalıç Adası/ Hagios Georgios), Ilıca South and Ilıca North with a rural building/farmstead on the Çerıklı Tepe (Fig. 5.2.1).

2. Landing sites and their relation to Pergamon and the Micro-Region

2.1 Harbors and ports

Three major harbor cities are connected to Pergamon: Elaia, at the estuary of the Kaikos River, Pitane, on the southern Kane Peninsula, and Kane, in the northwest part of the peninsula. At present-day Dikili, a location that may have been a possible fourth harbor for Pergamon, no ancient remains have been found so far.[490] This is surprising in a way, since Dikili today has a port in which agricultural products, coal, clay and various types of rock from the region are shipped.

Elaia

Keeping in mind that the city of Pergamon, located in the hinterland, was in various ways dependent on access to the sea, the question that arises is: Where did Pergamon install its harbors and did any of them play a primary role? In this context, Elaia had the advantage of local legacy since a small settlement with access to the sea existed here probably since the early Bronze Age.[491] Nevertheless, Elaia likely first rose in prominence beginning with its expansion by the Attalids in the 3rd century BCE as the main port of Pergamon.[492]

489 Mayer 2005, 33.

490 Stauber 1996, 257–258. 267; Zimmermann et al. 2015, 203.

491 Pirson et al. 2015, 37–38.

492 Pirson et al. 2015, 37; Feuser et al. 2018, 95–99.

The ancient harbor city lies in a gulf (Çandarlı Körfez) directly on the ancient coastal road coming from the south (Fig. 5.2.1). In the northern part of the long sea front of about one kilometer, two moles were erected forming a closed harbor.[493] The area behind the basin was filled and levelled in order to provide space for goods and warehouses for merchant shipping. Further south, protected boathouses used most likely as a naval base have been found. The southern half of the seafront was characterized by a beach that was included in the fortified area of the city and probably served as additional space for the landing of ships or dockyard-activities (Fig. 5.2.2). The parts of the open harbor with the ship sheds must have been silted up already in the early Roman Imperial period, while the closed harbor remained in function until Late Antiquity.[494]

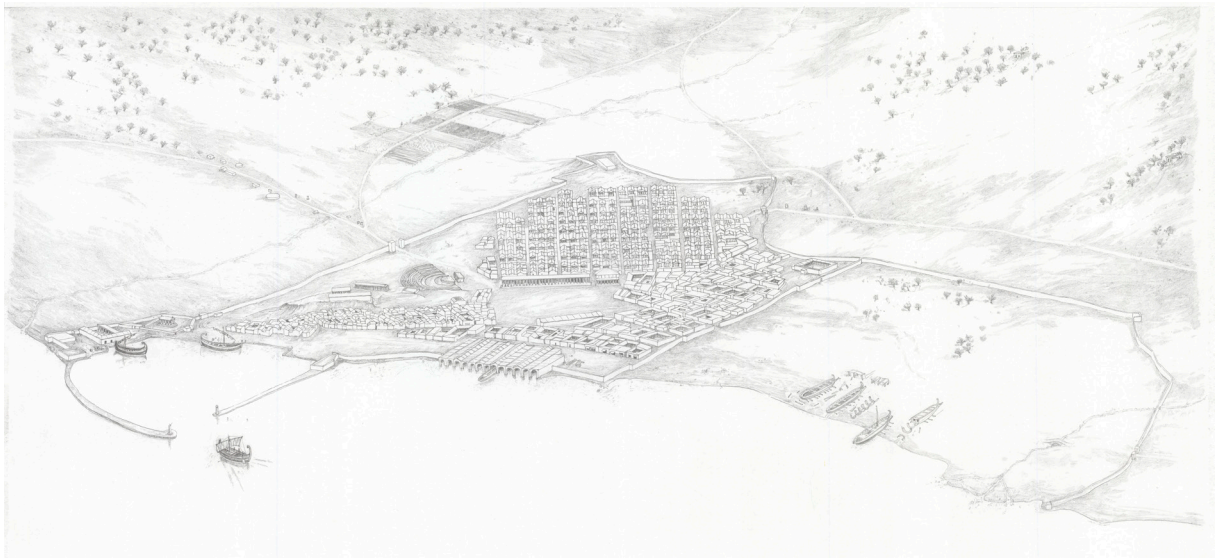

Fig. 5.2.2 Elaia. Reconstructive drawing of the harbor basin (left) and the harbor area of the Pergamene fleet (right)

For an ancient metropolis the size of Pergamon, its main harbor had to be easily accessible, and permanent communication within the micro-region guaranteed. Therefore, roads and paths were crucial elements within the micro-region. These connections structure the cultural landscape, connect places and often show a high degree of continuity. In order to assess the most efficient connection between Pergamon and the coast, a least-cost path analysis was carried out.

The results of the least-cost path analysis show that Elaia had a considerable advantage in travel time to Pergamon: a hypothetical trip with an oxcart from present-day Dikili or Pitane takes more than half a day longer (Fig. 5.2.3, Table 5.2.1). Considering the transport of heavy goods such as marble, which mostly came to Pergamon from Prokonnesos and therefore had to be shipped through the Dardanelles, such a difference was significant.[495]

As far as traffic to Pergamon is concerned, Elaia had another decisive advantage, which probably also played a major role in favoring the city. Thanks to its special location, it was not only the nearest port to

493 Pirson et al. 2015, 27–28. 32–34; Feuser et al. 2018, 91–103.

494 Feuser et al. 2018, 100–101; Seeliger et al. 2019.

495 For the import of marble from Prokonnesos, which was used, for example, in the Trajaneum or the Asklepieion, see Russell 2013, 147.

Pergamon, but also a natural checkpoint for the southern access to the Kaikos Valley via the coastal road. Therefore, Elaia is an excellent example of a bipolar polis with significant orientations towards both sea and land.[496]

Fig. 5.2.3 Possible paths in the Kaikos Plain between the coast and Pergamon and results of the least-cost path analysis

Table 5.2.1 Results of the least-cost path analysis

	Route to Pergamon in km	Days needed for a horse[1]	Days needed for a walker[2]	Days needed for an oxcart[3]
Elaia	27.15	0.34	0.92	2.31
Possible harbor near modern Dikili	32.92	0.41	1.12	2.80
Pitane	35.57	0.44	1.21	3.02
Kane	41.76	0.52	1.42	3.55

[1] Ø 55 m.p./d ≙ 80,85 km/d [2] Ø 20 m.p./d ≙ 29.4 km/d [3] Ø 8 m.p./d ≙ 11.76 km/d

496 Pirson 2014.

In assessing the physical and geographical conditions for a harbor location, the suitability of a site and its connectivity with the hinterland are not the only criteria which have to be taken into consideration. The visibility of the location and its surroundings, which depends to a large extent on the topography, must be regarded as an important factor for the location of sites in general.[497] Therefore, computer-based visibility analyses were carried out.[498]

Compared to Kane or Pitane, Elaia was visually remote. Even with a visibility range of 35 km, Elaia itself was not visible from a hypothetical sea lane along the coast (Fig. 5.2.4), although this could have been beneficial to a military naval base. At the same time, the question arises as to how the sea could be controlled from such a hidden situation. The surveillance of the sea would have been essential. In this context, a fortress on the Sakarkaya, a 330 m high rock southeast of Elaia, played a crucial role.[499] Its viewshed covers not only the western Kaikos Valley and reaches Pergamon, but includes Elaia, its bay

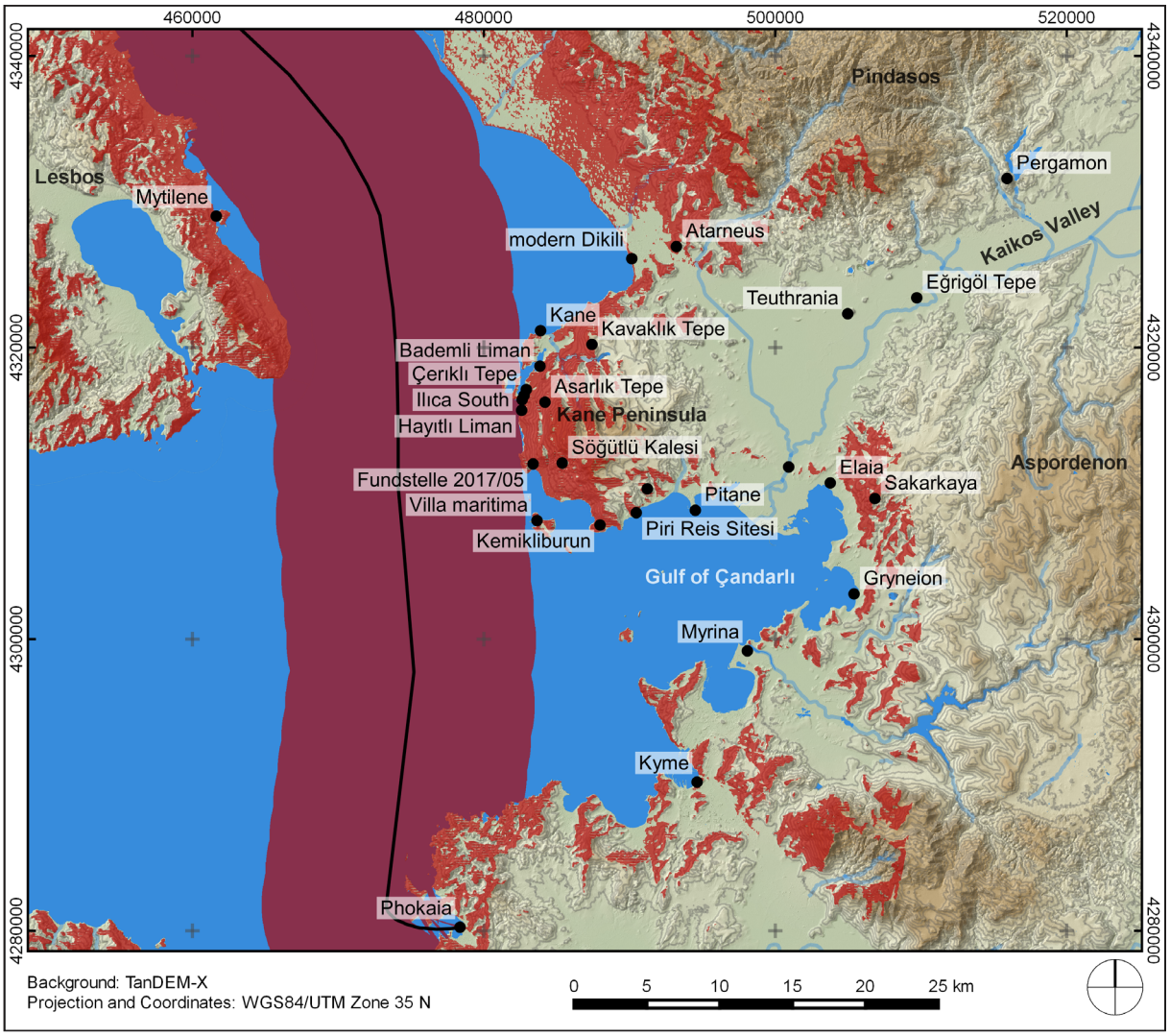

Fig. 5.2.4 Viewshed from a hypothetical sea lane from Phokaia to Adramyttion

497 Williamson 2014a; Williamson 2016; Turchetto – Salemi 2017.

498 The result of the visual analysis, a viewshed, indicates for each cell of the grid of the digital elevation model whether it is visible or not from the observation location. On the application and limitations of visibility analyses in archaeology, see Wheatley – Gillings 2000; Wheatley – Gillings 2002; Ogburn 2006; Llobera 2007.

499 Pirson 2010, 201; Pirson 2011, 171–174; Pirson 2012a, 226, Figure 27.

and the offshore Aegean Sea as well (Fig. 5.2.5). With the visibility of the position, it is not surprising that human activity from the Archaic into the Hellenistic period, with a clear peak in the latter period, has been verified on top of Sakarkaya. Furthermore, the remains of a fortification reflect the eminence of this place for the defense system of the Attalids. Keeping this in mind, one can speak of Sakarkaya as a place of visual control. Visual control can be defined as the "ability to observe many locations from a vantage point", which in this case applies in particular to the harbor of Elaia and the coastal road, an important crossing for most of the transport to and from Pergamon.[500] At the same time, the site could be seen from numerous places both in the Kaikos Valley and on the Kane Peninsula or the Gulf of Çandarlı: the site was visually prominent. This is defined as "the ability to be seen from many locations".[501] The Sakarkaya thus formed not only a widely visible landmark serving as an expression of Pergamene territory but also served as an important point of orientation for seafarers on their way to Elaia. Fig. 5.2.4 shows that the Sakarkaya was visible from the sea even when sailing past the Gulf of Çandarlı. Against this backdrop, the visually remote position of Elaia combined with the high visual potential of Sakarkaya proved to be a most advantageous combination for a military location with an action-range towards both land and sea.

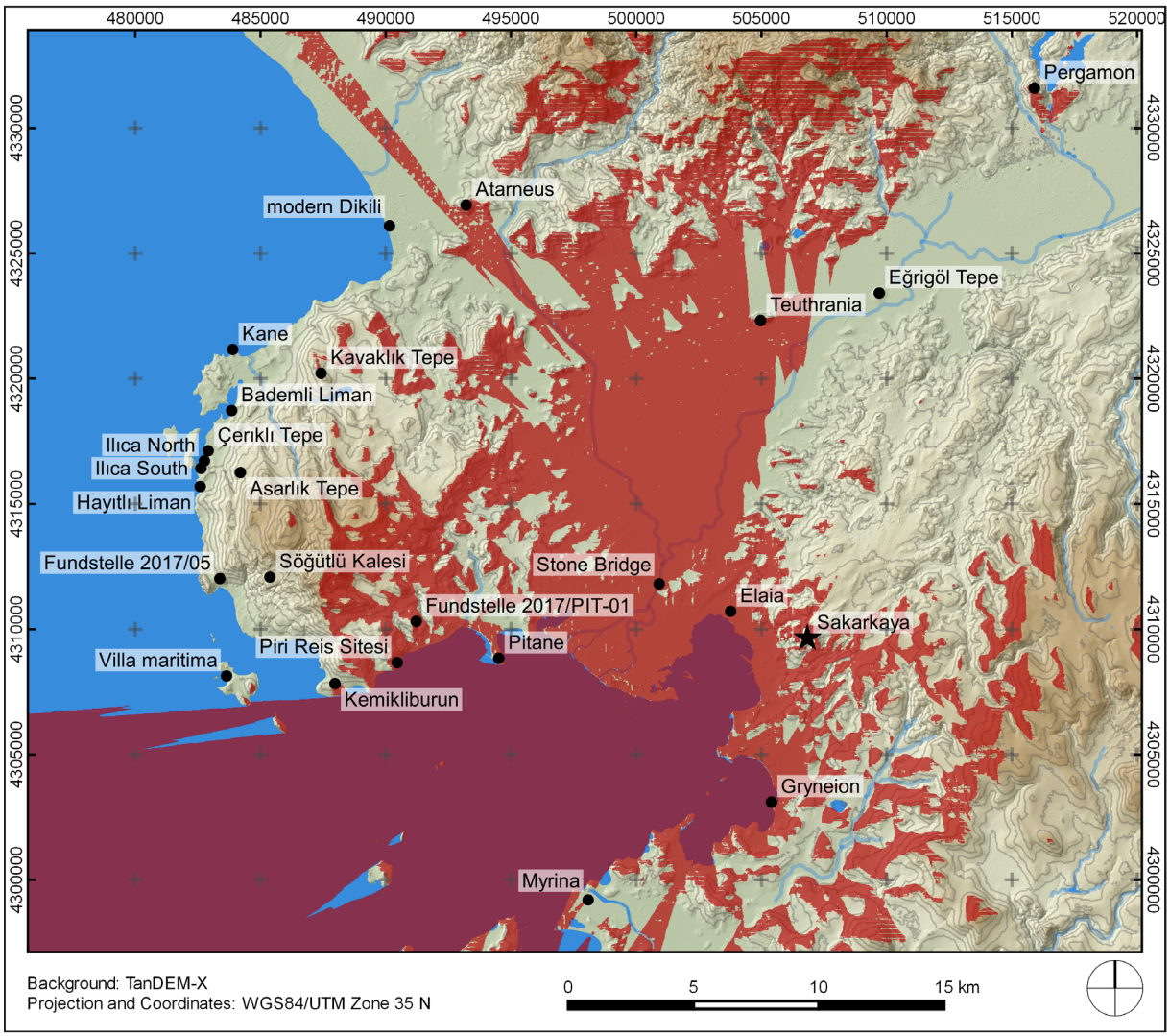

Fig. 5.2.5 Viewshed from Sakarkaya

500 Brughmans – Brandes 2017, 4.

501 Brughmans – Brandes 2017, 4.

Pitane

Pitane (Çandarlı) is located on a promontory on the southern edge of the Kane Peninsula 9 km west of Elaia (Fig. 5.2.1). Carl Schuchhardt describes the ancient remains of the city, which included its harbors – one in the west and one in the east – and a circle of at least seven watch towers in the vicinity, which probably secured the city in the Hellenistic period.[502] In recent years, portions of a sea wall have been documented and in the western present-day harbor basin foundations have been discovered that served as quay walls and port related buildings, which probably date back to the Roman Imperial period.[503] Numerous ancient pottery kilns on the peninsula are remains of pottery production specializing in exports.[504] Accordingly, the city's resource demands must have been high. The supply of wood for firing the kilns and raw materials such as clay had to be secured through the harbors. For a peninsular city like Pitane, the ports were the most important facilities for the city's economic success.

There are no visible traces today of the harbor described by C. Schuchhardt on the east side of the peninsula. In some areas, one can still see the remains of the surrounding ancient sea wall, but if the quay walls still exist, they are under the present-day promenade. No remains of a pier were able to be found in the water on this side of Pitane. C. Schuchhardt correctly stated that a pier on this side was not necessary, because the peninsula itself offered protection against the open sea and the west winds.[505]

On the western shore of Pitane, the remains of the ancient harbor and port can still be seen in the shallow water. The port area was enlarged by quay walls and rubble fills during the Roman Imperial period, so that at least one new port facility for storage or market activities with a size of 6 m x 25 m was constructed (Fig. 5.2.6).[506] Due to the above-mentioned west winds, this port needed a breakwater as protection. C. Schuchhardt's proposed reconstruction of a mole was not suitable for this purpose. A reef in the shallow water was discovered that extended the mole by about 350 m north. And since the sea level in the Roman Imperial period was about 1.5 m lower than today, the reef probably served as a natural breakwater.[507]

Pitane had two ports by the Roman Imperial period and their location enabled the exchange of goods, people and information relatively independent of season and weather conditions – a key factor for the accessibility from the sea. The more elevated parts of the peninsula were also visible from the hypothetical sea lane along the coast (Fig. 5.2.4). Thanks to this position, Pitane could be accurately approached from a greater distance. Arriving in Pitane, the protected harbor basin in the west, with an assumed size of approximately 8.5 hectares, was even larger than the closed harbor basin of Elaia with a size of 4.8 hectares.[508] If one combines these geographical advantages the question seems to be reasonable whether Pitane possibly served as a further main harbor supplying Pergamon and its micro-region.

502 Conze 1912, 99–102 (C. Schuchhardt).

503 Pirson 2016, 181–184; Pirson 2018, 157–160 (S. Feuser – E. Laufer).

504 Domżalski 2014.

505 Conze 1912, 100 (C. Schuchhardt).

506 Pirson 2018, 157–160 (S. Feuser – E. Laufer).

507 Pirson 2018, 157–160 (S. Feuser – E. Laufer).

508 See Pirson 2018, 160 (S. Feuser – E. Laufer) (Pitane); Seeliger et al. 2017 (Elaia); Fediuk et al. 2018 (Kane, Pitane, Elaia).

In the Roman Imperial period, the western port of Pitane was significantly expanded. On the one hand, this may have been related to the increasing importance of the harbor city as a pottery production center.[509] On the other hand, the relationship with Pergamon had also intensified. The latter was reflected in the construction of a stone bridge over the Kaikos River (Bakır Çay) 7 km east of Pitane.[510] The least-cost path analysis shows that this resulted in a road connection to Pergamon, which was no longer than approximately 35 km (Fig. 5.2.3, Table 5.2.1). Pitane was also connected to the ancient coastal road passing by Elaia. In addition to Elaia, heavy goods could now also be transported between Pitane and Pergamon via carts in just 3 days. It is possible that the expansion of the port and the construction of the stone bridge were reactions to Pergamon's increasing need for resources, due to its urban area spreading rapidly into the Kaikos Valley and the demand for large quantities of marble in the Roman Imperial period.[511] The bridge was therefore another key factor for the accessibility of Pitane and its connectivity to Pergamon.

Fig. 5.2.6 Pitane. Aerial photo of the western harbor basin with Roman structures under water. View from the south-west

509 Japp 2009.

510 See Conze 1912, 114 (C. Schuchhardt) and supplemental sheet 1. Another possibly ancient bridge was recently discovered 8 km northeast of Pitane: Pirson 2019, 124–125 (B. Ludwig).

511 On the use of marble in the Roman Imperial period, see Stiller 1895 (Trajaneum); Ziegenhaus 1981; Hoffmann 2011 (Asklepieion); Mania 2011 (Red Hall).

The landscape surrounding Pitane is characterized by the foothills of the Kara Dağ Mountains. The landscape offers numerous hilltops from which one has an excellent view over Pitane and the Gulf of Çandarlı. The city of Pitane in the Hellenistic period took advantage of this topography and built an entire circle of watch towers on these hilltops.[512] These were used for securing the city and were presumably based on visual connections. Of the at least seven watch towers that originally stood, current surveys have been able to locate at least one (Fundstelle 2017/PIT-01).[513] The viewshed of this site illustrates the excellent location of the watch towers in the vicinity of Pitane (Fig. 5.2.7). The view reaches from the Gulf of Çandarlı over Elaia and Sakarkaya far into the Kaikos Valley. Via these watch towers, Pitane, like Elaia, was able to visually control large parts of its offshore sea as well as its hinterland. This complements the already excellent visibility from the Pitane peninsula.

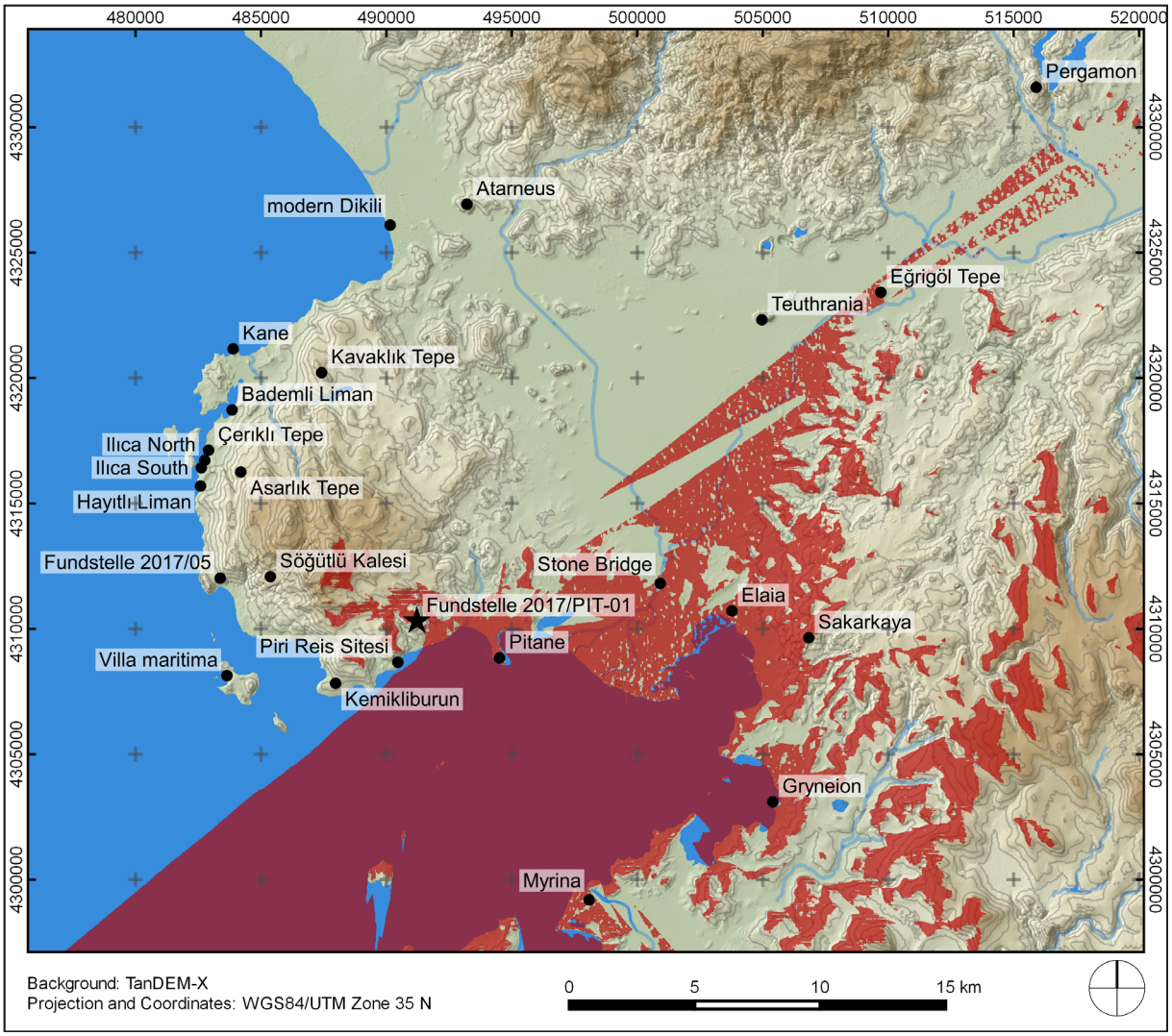

Fig. 5.2.7 Viewshed from Fundstelle 2017/PIT-01

512 Conze 1912, 100–101 (C. Schuchhardt).

513 See note 505.

Kane and the Arginusae Islands

Off the northwest coast of the Kane Peninsula there are the three Arginusae Islands (Garip Adaları). For a long time, only the two smaller islands were known, but recent geo-archaeological investigations have now shown that the northern peninsula is the third Arginusae Island (Fig. 5.2.1).[514] Around the 6th century BCE, the area between the island and the mainland was filled in so as to make the city more easily and permanently accessible.[515] This created a deep and protected bay in the south, which C. Schuchhardt described as a second, southern harbor of Kane, but without pointing to archaeological remains.[516] So far, no ancient remains have been found there, which is why it may have only served as an opportunistic port for Kane. In 191/190 BCE, a Roman fleet probably used this exact bay near Kane for wintering their ships on the shore (Livy 36, 45, 8 and 37, 8, 6).[517] In 1521 Piri Reis, the admiral of the Ottoman fleet and cartographer described the coastline near the two small islands, present-day Garip Adası and Kalem Adası, as a very good harbor with space for 100 ships[518], making it an excellent wintering place and more suitable than the northern bay. In addition, the Peloponnesian War was decided in the Battle of Arginusae in this area.[519] These examples suggest that the region around the Arginusae Islands offered favorable conditions for strategic fleet operations.[520] The nearest harbor city in this coastal region was the ancient city of Kane (Fig. 5.2.1). It is located on the northern and largest of the three islands near the present-day town of Bademli on a peninsula measuring approximately 400 m x 150 m (Fig. 5.2.8). This peninsular location leads one to assume that Kane, like Pitane, had two harbors in the east and in the west. Current surveys have documented likely Hellenistic structures to the east of the peninsula, which have been interpreted as fortification walls and a tower and their use as quays is unlikely.[521] The north-western tip of the peninsula is connected to a natural breakwater, which has been artificially strengthened. This creates a protected harbor basin with a size of approximately 0.5 ha.[522] During the Roman Imperial period, a bank reinforcement or a small quay wall made of *opus caementitium* was erected.[523] Although Kane was relatively insignificant for Pergamon from an economic perspective, it played an important strategic role for the metropolis. One must nevertheless ask what role Kane played in supplying the Pergamon Micro-Region?

The results of the least-cost path analysis make clear that the route from Kane to Pergamon was long and time-consuming (Fig. 5.2.3, Table 5.2.1). Many goods, such as the above-mentioned marble deliveries from Prokonessos, were therefore certainly transported by ship past Kane to Pitane or Elaia, where they were reloaded for further transportation to Pergamon. Alternative roads through the Kara Dağ

514 Pirson 2016, 185–190 (M. Seeliger – A. Pint – M. Herbrecht – H. Brückner).
515 Pirson 2016, 189 (M. Seeliger – A. Pint – M. Herbrecht – H. Brückner).
516 Schuchhardt 1887, 1209.
517 Stauber 1996, 282–283.
518 Kahle 1926, 40.
519 For the battle formations around the Arginusae Islands, see Hamel 2015, 45–50 with Map 4.
520 Schuchhardt 1887, 1209.
521 Pirson 2018, 152–157 (S. Feuser – E. Laufer).
522 Pirson 2016, 175 (E. Laufer); Fediuk et al. 2018.
523 Pirson 2018, 156 (S. Feuser – E. Laufer).

Mountains are only known from Kane south to Asarlık Tepe and probably further to Söğütlü Kalesi.[524] Kane therefore likely operated economically only in the immediate area rather regionally. The city's economy was concentrated on agricultural products from its *chora* and the harbor served the local sea trade.[525] In terms of supplying the micro-region and Pergamon, the accessibility of Kane was rather poor.

Nevertheless, at least in the Hellenistic period there was a high level of connectivity with the hinterland. Communication between Kane and the Pergamon Micro-Region was ensured through the construction of a small fortress on the Kavaklık Tepe (Fig. 5.2.1), located on a ridge about 3.7 km southeast of Kane in the Kara Dağ Mountains. The fortress would have served as a visual hub between Kane, the Arginusae Islands and both Pergamon and the larger Kaikos Valley – an observation that C. Schuchhardt already recognized and described in 1887. Due to the inter-visibility of the places, simple signals, at the very least, could be transmitted quickly from the otherwise remote harbor city. In addition, there was a direct line of sight to Mytilene on Lesbos, the role of which, together with other lines of sight, has to be investigated in a separate study on the visibility network in the Pergamon Micro-Region.

Looking at a hypothetical sea lane from Adramytteion to Phokaia along the Kane Peninsula, the specific function of Kane, with its well-protected natural bay and the nearby Arginusae Islands, becomes clearer (Fig. 5.2.4). For the Attalid rulers of Pergamon who controlled landing sites in the region, it was crucial to

Fig. 5.2.8 Kane. Aerial photo of the peninsula and the harbor basin. View from the east

524 Pirson 2016, 184–185 Fig. 47 (E. Laufer); Tozan 2017.

525 Pirson 2015, 149 (E. Laufer).

have a safe stopover on the sea lane leading from the Dardanelles and the island of Lesbos to their main port at Elaia. The weather and winds in this region could be very strong and dangerous even in summer. For example, a storm prevented the Spartan fleet from sailing from Mytilene on Lesbos to the Arginusae Islands on the eve of the Battle of Arginusae.[526] One day later after the battle, strong winds prevented the Athenian fleet from rescuing their shipwrecked[527], with far-reaching consequences for their generals[528] and the history of Athens. This particular geographical situation would also explain why the Attalids invested in this otherwise remote and economically insignificant place. The integration of Kane and the Arginusae Islands in the visual region of Pergamon further corroborates its strategic importance.[529]

The possible harbor of Atarneus near present-day Dikili

The city of Atarneus was situated on a hill in the north-west of the lower Kaikos Valley – today 3 km away from the coast and the present-day harbor city of Dikili (Fig. 5.2.1), and was one of the most important cities in the region before the Attalid dynasty.[530] While Pergamon prospered in the following period, the decline of Atarneus began in the 1st century BCE.[531] Until then, the city occupied a strategically important point in the landscape, located on the ancient coastal road at the northern entrance to the Kaikos Valley and in the immediate vicinity of the coast. One would assume that Atarneus also had its own harbor somewhere near present-day Dikili. However, no archaeological evidence has yet been found, but it is possible that the ancient remains are covered by the present-day city.

The name Atarneus could have been transferred to its harbor after the decline of the city.[532] A customs inscription from the 1st century BCE also mentions Atarneus in the list of port customs offices in the province of Asia.[533] Hence a harbor close to Atarneus may have been operated at this time, but archaeological evidence is still lacking.[534] Even after the decline of Atarneus during the 1st century BCE, a potential harbor may have continued to exist and could have played a role in the connectivity of the Pergamon Micro-Region. The location is comparable to Elaia and the least-cost path analysis shows that the distance to Pergamon was approximately 6 km longer than from Elaia, or even less, if one suspects an ancient coastline further inland and one moves on a more direct path through the Kaikos Valley (Fig. 5.2.3, Table 5.2.1). Access to the sea at this point in the micro-region might have offered an alternative for Pergamon to Elaia in terms of distance.

2.2 Opportunistic ports

Besides the harbors and ports described above, further landing sites along the coastline of the Pergamon Micro-Region are known. These are not characterized by harbor basins for larger ships, but instead

526 Kagan 1987, 340 with note 54; Kagan 2003, 454; Hamel 2015, 46.

527 Kagan 2003, 460–461; Hamel 2015, 55–56.

528 Kagan 1987, 354–375; Kagan 2003, 461–466; Hamel 2015, 71–90.

529 For the visual region of Pergamon, see Williamson 2016; Pirson – Ludwig (in press).

530 Pirson – Zimmermann 2014, 153–160; Zimmermann et al. 2015, 193–207.

531 Zimmermann et al. 2015, 205–207.

532 Stauber 1996, 257–258.

533 Stauber 1996, 267.

534 Zimmermann et al. 2015, 203.

usually by a simple beach which was sufficient as an anchorage for lighter boats. Therefore, they are difficult to prove in the archaeological record. J. Leidwanger hypothesizes that these sites, which he describes as opportunistic ports, functioned as places for the exchange of goods with the hinterland, widely independent of the large harbor cities.[535] A further characteristic of these landing sites is that they could have been used at varying times, e.g., seasonally for the transport of certain agricultural products.

Bademli Liman

The present-day fishing village of Bademli Liman is situated two kilometers south of Kane on a small bay (Fig. 5.2.1). A survey carried out in 2015 revealed pottery scatters near the present-day pier dating from Hellenistic period to Roman Imperial and Byzantine periods, but no other remains are preserved from the ancient usage of the bay.[536] This section of coast can therefore be described as a landing site or opportunistic port. This may also be the second southern harbor of Kane mentioned by C. Schuchhardt.[537] From an economic perspective, the place was rather insignificant, and probably served for the exchange of local agricultural products. From a military point of view, however, control of the bay could have been of great importance. It offers sufficient space for a large number of ships or even entire fleets that could be safely landed on the shallow beaches and were protected from weather and enemies by the largest of the three Arginusae Islands. An excellent example of this is the wintering of the Roman fleet whose ships likely landed in 190/191 BCE in this bay (Livy 36, 45, 8 and 37, 8, 9).

Fundstelle 2017/05

Halfway between Çandarlı and Bademli lies the village of Denizköy, situated in a small bay. Since the coast in this area is usually steep and rocky, the beach of the Denizköy bay offers the rare opportunity to land using small boats (Fig. 5.2.1). Surveys in recent years have not found any evidence of its ancient use as a harbor, but high above the bay on a hill a site was discovered in 2017: a watch tower with a surrounding wall that probably dates back to the Hellenistic period.[538] This structure has a direct connection with the bay, traceable using the viewshed of the site (Fig. 5.2.9). The tower was built so as to have as strong a view as possible over the bay but not towards the open sea. Otherwise, the tower would have been built on the more elevated Maltepe west of Denizköy. Since a certain effort was made to visually control and secure the bay, it must have played an important role in the Hellenistic period as a landing site or opportunistic port. The extent to which the bay, with its watch tower, was integrated into a higher-level visibility network remains to be investigated.

Kemikliburun

Cape Kemikliburun is located in the southwestern portion of the Kane Peninsula (Fig. 5.2.1). At its highest point there are remains of a Hellenistic watch tower with a surrounding wall, which was probably intentionally oriented towards the northern bay through terracing of the terrain.[539] Its viewshed shows that the bay was easily visible from this tower and therefore could be visually controlled (Fig. 5.2.10).

535 Leidwanger 2013, 233–240.

536 Pirson 2016, 177–178 (E. Laufer).

537 Schuchhardt 1887, 1209.

538 Pirson 2018, 161–164 (S. Feuser – E. Laufer).

539 Pirson 2019, 118–120 (B. Ludwig).

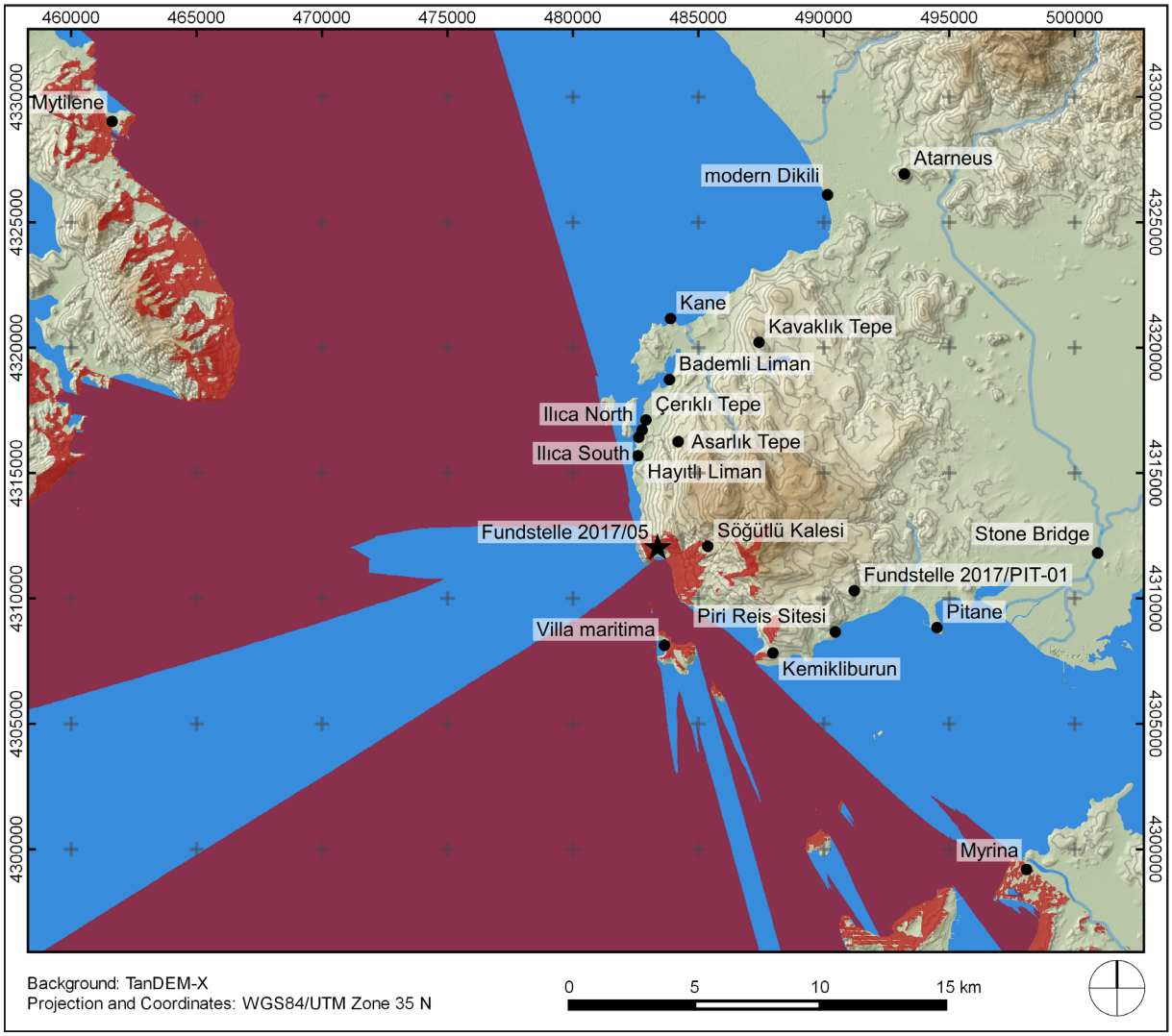

Fig. 5.2.9 Viewshed from Fundstelle 2017/05

The situation is similar to that of Fundstelle 2017/05 and the bay itself is well protected and hidden by the offshore islands and the cape Kemikliburun. Compared to the relatively steep cliffs in this area, the terrain behind the bay rises more gradually. The bay is therefore relatively easy to reach, considering the conditions of the coastline. In the bay itself there are no remains indicating the use of the harbor, but the larger setting suggests that this bay was also used as an opportunistic port, secured by a watch tower in the Hellenistic period.

Bays of Hayıtlı Liman and Piri Reis Sitesi

The bays of Hayıtlı Liman and Piri Reis Sitesi have been surveyed in recent years, but no ancient remains have been found so far (Fig. 5.2.1).[540] Because lighter boats did not need any built installations for anchoring or landing, the lack of archaeological findings does not exclude their use as opportunistic ports.

540 Pirson 2018, 166 (S. Feuser – E. Laufer).

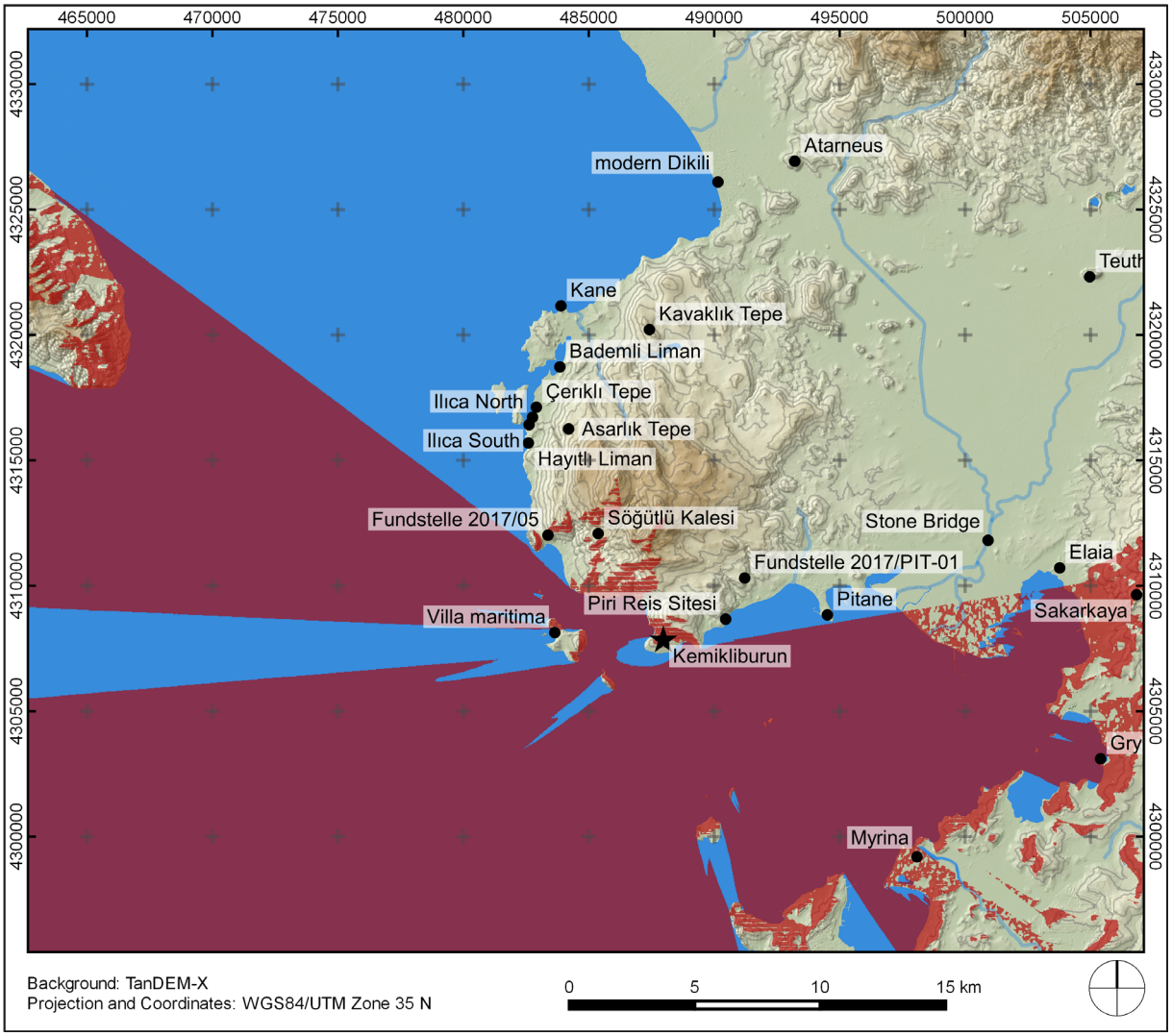

Fig. 5.2.10 Viewshed from Kemikliburun

2.3 Villae marittimae

Ilıca South and Ilıca North with a farmstead on the Çerıklı Tepe

About 4.5 km south of Kane numerous thermal springs can be found, and Ilıca South and Ilıca North are also located along this section of the coast (Fig. 5.2.1). The position of the two sites offers topographic advantages, such as the short distance to Kane and protection from storms and heavy seas by the Arginusae Islands.

Ilıca South is a building complex approximately 30 m long dating back to the Roman Imperial period.[541] Ilıca North is a large building complex whose remains are now partially under water and date to the same period. Due to the size of the complex (approximately 500 sqm) Ilıca North has been interpreted as a *villa maritima* and, because of the thermal springs, likely with its own bathing complex.[542] Although no evidence of quay walls or other port facilities have been found, it can be assumed that there was an appropriate facility for daily passenger traffic and for the supply of the *villa maritima*.

541 Conze 1912, 118 (C. Schuchhardt); Pirson 2016, 178–179 (E. Laufer).

542 Pirson 2016, 179 (E. Laufer); Pirson 2018, 164–165 (S. Feuser – E. Laufer).

Only 400 m further north on the Çerıklı Tepe, archaeological finds point to a farmstead that was probably related to the Ilıca North.[543] Although *villae maritimae* are associated primarily with luxury and *otium*[544], as evidenced by the use of the hot springs in Ilıca North and Ilıca South, recent research shows that they also had agricultural estates characteristic of villas located inland.[545] The farmstead on the Çerıklı Tepe could be such a facility and its agricultural production could have served to supply the *villa maritima* or the household the owner ran in Pergamon. There was also the possibility of a cost-efficient transport of the products by sea to a harbor which was well connected to the road network to Pergamon.

Villa maritima on Elaioussa (Mardalıç Adası/ Hagios Georgios)

The island of Elaioussa (Mardalıç Adası or Hagios Georgios) is situated southwest of the Kane Peninsula (Fig. 5.2.1).[546] The ruins of a Roman building complex (late 1st century to 1st half of 2nd century CE), which has been interpreted as a *villa maritima*, lie on a narrow promontory separating two small bays (Fig. 5.2.11).[547] The exceptional topographical situation makes it possible to dock a boat from both sides of the main building, and here the inhabitants and visitors would have arrived, coming from the mainland. Whether they used one of the nearby bays (Fundstelle 2017/05 or Kemikliburun) or one of the larger

Fig. 5.2.11 Elaioussa. Aerial photo of the *villa maritima*. View from the east

543 Pirson 2018, 164–165 (S. Feuser – E. Laufer).

544 Marzano – Métraux 2018b, 25–27.

545 Marzano 2018, 136.

546 Stauber 1996, 288–289.

547 Hoffmann 1993; Pirson 2016, 180–181 (E. Laufer).

harbors (Kane, Pitane or Elaia) is difficult to tell. But the owner who wanted to enjoy the amenities of the *villa maritima* of Elaioussa very likely used Elaia as a transfer terminal. After a short distance over land, he would have had to take a boat along the coast through the Gulf of Çandarlı to Elaioussa – almost a day's journey. An estate with such an exclusive view also gave the owner, probably a member of Pergamon's senatorial aristocracy[548], a sense of control over this coastal area (Fig. 5.2.12). At the same time, *villae maritimae* were built to be viewed.[549] The villa on Elaioussa could be seen both from the sea (Fig. 5.2.4) and from the coast of the Kane Peninsula. The viewsheds of the sites Fundstelle 2017/05 (Fig. 5.2.9) and Kemikliburun (Fig. 5.2.10) provide good examples.

However, the question arises as to whether the piers of the villa were also used for the exchange of agricultural goods at the same time. The ancient name Elaioussa means 'olive grove'[550], and ancient remains of agricultural production are found across the whole island.[551] It was not unusual that *villae*

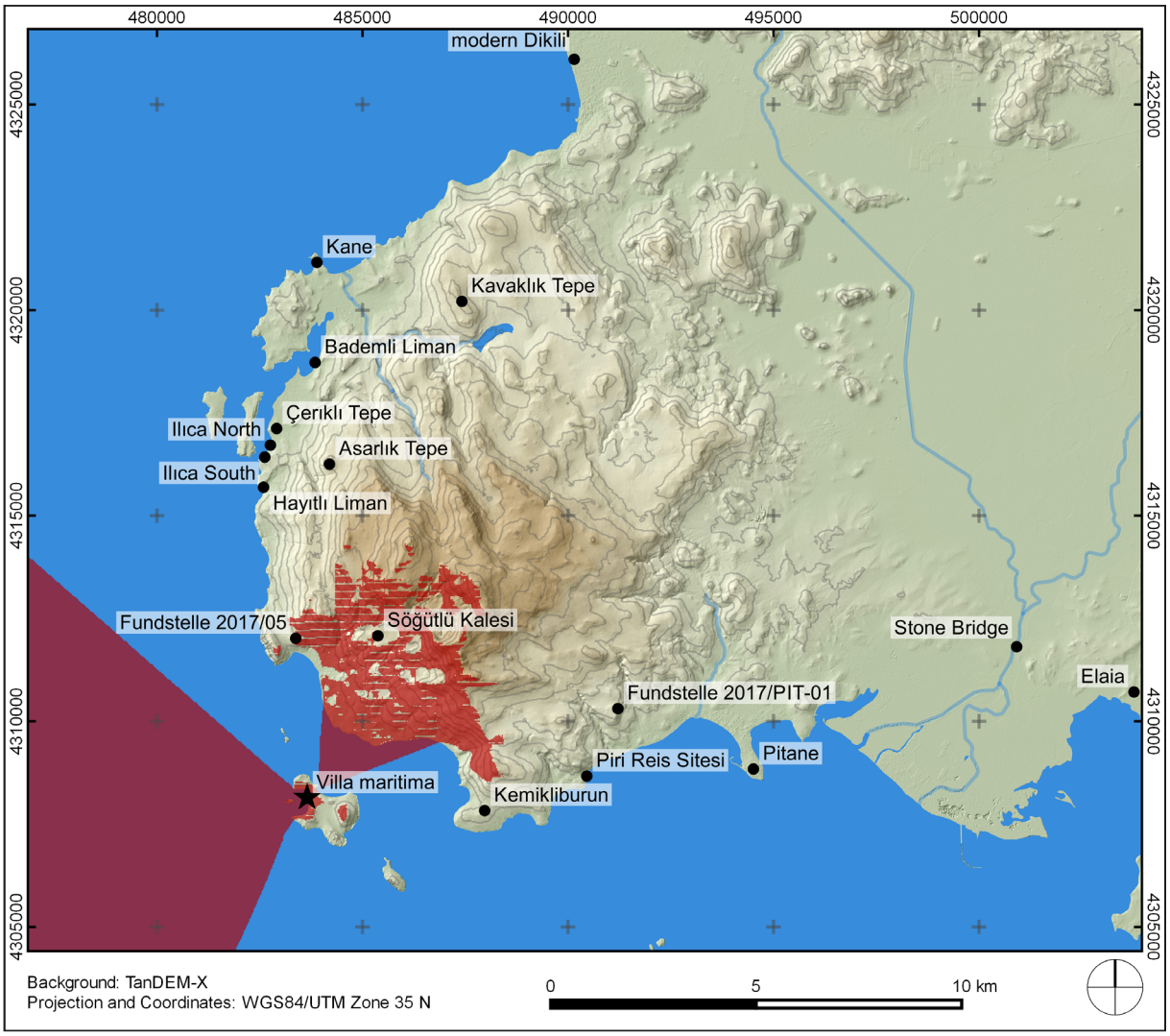

Fig. 5.2.12 Viewshed from the *villa maritima* on Elaioussa

548 Pirson 2017, 112–113.

549 Marzano 2018, 126.

550 Heinle 2015, 28.

551 Pirson 2016, 181 (E. Laufer).

maritimae were also part of an estate producing oil or wine.[552] As previously mentioned oil and other agricultural products may have served to supply the villa or other households of the owner. Here, as well, any (seasonal) surpluses could be cost-efficiently shipped to Kane, Pitane or Elaia via the facilities of the *villa maritima*.

3. Conclusion

Landing sites in general played a crucial role for the development and success of Pergamon and its micro-region. The aim of this paper was to discuss the different types of landing sites according to their various significances and hierarchy. And although the archaeological record of landing sites along the coast is difficult to trace or has been entirely destroyed by natural or anthropogenic factors, established digital tools such as visibility analysis or least-cost path analysis allow conclusions to be drawn about the function of ancient landing sites and their relationship to Pergamon and the micro-region.

The results of the visual analyses and least-cost path analyses confirm the accepted statement that Elaia had been the main port and naval base of Pergamon since Attalid times. The topography of the city and its surrounding landscape were crucial factors in the decision to install Elaia as the primary port. The route from Pergamon to Elaia was the shortest path to the sea and offered an economic advantage for the transport of people and goods and the exchange of information. At the same time, the position was a natural checkpoint at the southern access to the Kaikos Valley via the coastal road. This checkpoint and the port, which was otherwise remote from the sea, were visually controlled and secured via the fortress on the Sakarkaya, which also served as a landmark for seafarers on their way to Elaia. These factors led to a primacy of Elaia, which is also testified by the local coinage.[553]

From an economic perspective, Pitane gained significant importance during the Roman Imperial period due to the expansion of the port area and the construction of a stone bridge on the road to Pergamon. Pitane had a growing pottery industry and two harbors that made the city reachable almost independent of seasons and weather. The western harbor basin was almost twice as large as that of Elaia and Pitane was certainly the second main port for Pergamon offering long-term locational advantages over Elaia, whose harbor basin later became silted. Along the coast between Dikili and Elaia, Pitane/Çandarlı is the only place with a maritime continuity, to which the presumed expansion of the harbor in the Roman Imperial period may have contributed. Even in 1521 Piri Reis recommended Pitane/Çandarlı as the harbor of choice in this area, which could also be reached by large ships.[554]

Kane had significant economic disadvantages compared to Elaia or Pitane. But the harbor city was nevertheless located in a strategically important area of the sea where fleets wintered and sea battles had been fought using the special maritime topography of the Arginusae Islands. Kane with the nearby Arginusae Islands were therefore of strategic and military importance to Pergamon and served as a safe stop-over for ships on their way to Elaia or Pitane.

552 Marzano 2018, 126.

553 On coins from Elaia, see Chameroy 2012; Pirson 2015, 157–158 (J. Chameroy).

554 Kahle 1926, 41.

The watch towers erected in the Hellenistic period above the bays of Fundstelle 2017/05 and Kemikliburun and around the harbor cities during the Roman Imperial period lost their importance when Pergamon became part of the Roman province. Whether they were destroyed or abandoned is difficult to say. The watch towers were at least no longer used as security installations integrated into a superordinate visual control system connected to Pergamon[555], and Kemikliburun seems to be used for agricultural purposes afterwards.

As the focus of the region changed from military strategy to leisure, numerous thermal baths were built in the Pergamon Micro-Region. A special form of this rural bathing and *otium* culture were *villae maritimae*, which appeared along the coast, especially at hot springs, but also on the island of Elaioussa.[556] They were usually just a day's journey from Pergamon and indicative of the transformation of the coastline.

Over centuries, access to the sea remained vital for the remote metropolis of Pergamon and its micro-region, but while military aspects were a major concern in the Hellenistic period, trade and leisure became increasingly important during the Roman Imperial period. The landing sites on the Pergamene coastline reflect these changing needs and provide essential evidence of the networks and dynamic spaces of interaction within the Pergamon Micro-Region.

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555 A separate paper on this topic is in preparation.

556 On rural bathing and otium culture in the Pergamon Micro-Region, see Dally et al. 2012, 112–113.

5.3 A Landscape of Surveillance. Investigating Hellenistic Fortifications and Potential Networks of Interaction in the Pergamon Micro-Region

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Abstract

This study presents a three-pronged landscape approach that combines visibility analyses, site location analyses, and the modeling of movement in an open-access environment as a comprehensive means of assessing degrees of surveillance and control of a territory. The study focuses on the Pergamon Micro-Region under the Attalid dynasty in the turbulent Hellenistic era. While unrestricted and permanent access to the surrounding core territory was vital to their success, our knowledge of the rural fortifications and the protection of this particular region is fragmentary.

We have therefore carried out a full analysis of all the known fortifications in the Pergamon Micro-Region in terms of their function and ability to monitor and control the surrounding landscape from the city. The results yield new insights into Pergamon's strategic position as a regional center of power and communication through its deployment of rural fortifications to monitor, control and access areas of economic, strategic and military importance. The methodology shows how prominent locations were integrated into a system of defense that lost its functionality after Attalid rule. By also making the developed code of the analyses available alongside the study, we make our assumptions and decisions transparent and reproducible, encouraging readers to perform and test the analyses, or further develop them for their own specific research question.

Keywords: Pergamon, Landscape Archaeology, Fortification, Visibility Analysis, Topographic Position Index, Geomorphons, Isochrones, Reproducible Research

1. Introduction

In order to understand the vitality of an ancient city one must focus on its wider environment[557]. Reliable accessibility and control of the essential landscape that provided fundamental resources, including food and routes of trade and communication, were basic requirements for the emergence and development of an urban center. The location within the landscape had to guarantee the security of the city itself and at the same time meet the above-mentioned needs. Compared to ancient coastal cities such as Ephesus or Smyrna, this posed a particular challenge for Pergamon, located about 25 km inland on a steep hill at the northern edge of the lower Bakırçay Plain (ancient Kaikos Plain). The distance from the coast is generally seen as an economic disadvantage[558]. Nevertheless, the location offered a panoramic view of the vicinity as well as higher security[559], especially in the turbulent Hellenistic period[560]. The sheer number of known fortified settlements and military forts in the western lower Bakırçay Plain and the surrounding mountain ranges, which remained the heartland of Attalid territory throughout their rule, indicates the high importance of military presence at that time. The necessity of visual control over the territory of a city was already noted by Aristotle, who prescribed that a city should be able to oversee its territory in a single glance and that for secure communication, defense and access to resources, every part of the territory should be in visual contact with all the other parts[561]. The takeover and control of strategic locations allowed unrestricted and permanent access to the core-territory and was therefore essential for the stability of the Attalid dynasty.

Our knowledge regarding the protection of Pergamon's core territory is fragmentary and we can only provide general concepts as we await further investigations. Nonetheless, a close examination of the placement of fortifications in the landscape and the factors that commanded them will allow us to assess the potential of an interactional defense network with Pergamon as a central node. Our aim is to analyze these fortified places in their physical contexts in order to better understand their functions and to develop prognoses regarding the city's ability to control its surrounding landscape. The analyses are based upon digital elevation data and are employed in a script-based environment using free and open-source software to enable their reproduction[562]. The paper applies a novel combination of three different, landscape-based approaches: visibility analyses, site location analyses, and the modeling of movement, all of which are reproducible with the data provided.

A prerequisite for networking and communication is a simultaneous occupation of or at least access to the fortified places, which is assumed as a hypothesis in this study. Inter-visibility among these and with Pergamon would be necessary for any type of signaling to create a visual communication network, one that was surely much faster than physical travel and therefore more effective for surveillance[563]. Whether such visual relationships actually existed and whether they were intentionally created to establish a

557 Rich – Wallace-Hadrill 1991; Lang 1999; Zimmermann 2015a; Zuiderhoek 2017.

558 Knitter et al. 2013; Radt 2016, 17–20.

559 Radt 2016; Radt 2018.

560 Marek – Frei 2017, 238–391.

561 Aristotle, Politica 7.1327a; Koparal 2009, 501.

562 Code and data are published on Zenodo: Knitter et al. 2021.

563 E.g., Clark – Parker 1987.

network of surveillance as part of an Attalid defense strategy will be assessed through various visibility analyses.

Visibilities within a landscape are highly dependent on topography and are not the only factor in the selection of site locations. Therefore, additional geomorphometric analyses will be conducted for a better understanding of the site locations in relation to strategic targets, such as roads, communities, and vital resources, as well as with the overall local topography.

Visual control of important areas such as valleys, roads or harbors is an important factor for the security of a region, but the ability to mobilize military resources in time is just as important. Besides a good overview, the ability to reach critical points in the monitored area would also have determined the site locations of fortifications. Due to the heterogeneous landscapes, regions in the Bakırçay Plain would have been more readily accessible than narrow tributary valleys, plateaus, or ridges. To objectively estimate travel times from the fortifications through their immediate surroundings, we calculated isochrones (lines of equal travel time), indicating all the areas that can be reached within a given time[564]. Based on these analyses, it can be assessed whether a lack of inter-visibility could be bridged with movement between fortifications in the context of communication. Furthermore, it can be determined to what extent the positioning of the fortifications was aimed at reaching strategic areas or targets, or how large their hypothetical area of control was. In addition, the isochrones show whether and to what extent all important places and areas in the Pergamon Micro-Region could be reached by one of the fortifications within a certain time.

By combining these landscape-based analyses with recent and ongoing field research[565], a comprehensive picture of the characteristics and structure of the command over the landscape around the Hellenistic royal seat of Pergamon will be drawn. The inclusion of results from current fieldwork and newly discovered sites is a great advantage in this study. Ongoing fieldwork also allows a better assessment and interpretation of the analyses. The transparency and traceability of our decisions and results are ensured by the publication of the code and data in the analyses.

2. Landscape, Fortifications, and Visual Relations in the Pergamon Micro-Region

Ancient Pergamon is situated on a steep hill some 25 km inland at the northern edge of the lower Bakırçay Plain (ancient Kaikos Plain) (Fig. 5.3.1). The surrounding landscape is very heterogeneous, characterized by several mountain ranges, flat and wide plains, isolated hills and the Aegean coastline. The center was the lower Bakırçay Plain, framed to the north by the Kozak and Madra Dağı Mountains

564 Becker et al. 2017; Oltean – Fonte 2021.

565 'Elaia: Eine aiolische Polis als Subzentrum der hellenistischen Metropole Pergamon' (F. Pirson) and 'Landstädte, Dörfer und Gehöfte in der Chora des hellenistischen Pergamon' (M. Zimmermann) were funded within DFG-Schwerpunktprogramm 1209 'Die hellenistische Polis als Lebensform. Urbane Strukturen und bürgerliche Identität zwischen Tradition und Wandel' (2006–2012). 'The Maritime Topography of the Ancient Kane Peninsula: A Micro-Regional Approach to the Impact of Harbours and Anchorages on Politics, Economy and Communication of a Western Anatolian Landscape. Kane Regional Harbour Survey (KRHS) 2014–2018' (F. Pirson) was part of 'Portus Limen – Rome's Mediterranean Ports' (S. Keay) and financed by the European Research Council (European Union's Seventh Framework Program FP7/2007–2013). 'Die Transformation der Mikroregion Pergamon zwischen Hellenismus und römischer Kaiserzeit' (2019–today, F. Pirson, B. Schütt, T. Schulz-Brize) is an ongoing project funded by the German Research Foundation (DFG).

(ancient Pindasos, 1,343 m), to the south by the Yunt Dağı Mountains (ancient Aspordenon, 1,076 m), and to the west by the Kara Dağı Mountains (ancient Kane, 772 m) on the Kane Peninsula. This region is defined as the Pergamon Micro-Region, a dynamic space of interaction between humans and their natural environment with an extent that varies according to the level of interaction as well as diachronic changes[566]. The Pergamon Micro-Region thus provided essential resources[567], ensured access to important transportation and communication routes[568], and had a high religious value as a sacred landscape through the creation of rural sanctuaries and tumuli as landmarks[569].

The landscape of the micro-region was included in the archaeological investigations from the early stages of systematic fieldwork on as an important context for understanding the history of the city. The geography and geology of the surrounding countryside were elaborately described and mapped in the early 20th century[570]. Even today, topography is seen as a determining factor in the placement of specific

Fig. 5.3.1 The Pergamon Micro-Region: Lower Bakırçay Plain and adjacent Madra Dağı, Kozak, Yunt Dağı, and Kara Dağı Mountains. The study area stretches between Pergamon and the coastline.

566 Pirson 2017, 92; Pirson 2020, 158; cf. Horden – Purcell 2000; Zimmermann 2015a; Schuler 2016.

567 Sommerey 2008, 159–169; Pirson – Zimmermann 2014; Laabs – Knitter 2021.

568 Tozan 2017; Feuser et al. 2020; Laufer 2020; Ludwig 2020; Ludwig 2022.

569 Wulf 1999; Agelidis 2009; Pirson et al. 2011; Agelidis 2012; Pirson 2012a, 219–225; Ateş 2014; Williamson 2014a; Williamson 2016; Pirson 2017; Pirson – Ludwig (in press).

570 Philippson 1902; Conze 1912, 43–59 (A. Philippson).

sites at specific locations within the landscape[571], which is why detailed studies on the relief of the micro-region and its dynamics are also structurally part of current research[572].

Based on the current state of research on the historical landscape and the archaeological record, this study focuses particularly on the western part of the Pergamon Micro-Region: the western lower Bakırçay Plain with the adjacent mountains, the Kane Peninsula and its coastline. The eastern part of the micro-region as well as the more mountainous regions will be included in future research, supported by new fieldwork. Our approach extends the work of Christina G. Williamson, who for the first time applied Geographic Information System (GIS)-based visibility analyses in the Pergamon Micro-Region to examine visual relationships of (fortified) sites and their relationship to their environment in the western Bakırçay Plain[573].

The Attalids, whose control over the area extended from the early 3rd century until the latter part of the 2nd century BCE, are known to have anchored their rule to Pergamon and its landscape. Their territorial claims were made manifest through the strategic placement of rural sanctuaries in Kapıkaya or Mamurt Kale and visually significant funerary-monuments near the city[574]. These elements served as landmarks within the micro-region and created visual reference points within Pergamon's core territory. But in order to be able to assert and defend their territorial claims, especially in the transitional and volatile Hellenistic period[575], the Attalids installed military facilities at strategic locations surrounding the city and in its vital hinterland[576]. This is testified, for example, by an inscription mentioning a fortress in the Yunt Dağı Mountains near the present-day village of Yaylaköy[577]. Furthermore, it is attested that the area around Pergamon was under attack by the Gauls and rival rulers such as Philip V[578]. Fortifications at strategic locations enabled the control over the extensive territory while serving simultaneously as landmarks of Attalid presence. John Ma referred to Attalid Asia Minor as a 'militarized landscape', but this is noticed even at a regional level[579]. The first generation of researchers at Pergamon already discovered a large number of Hellenistic fortresses in the Kara Dağı Mountains and near the harbors of Kane[580] and Pitane[581] in the late 19th century[582]. In the following years, up to 14 watchtowers were postulated for the Kara Dağı Mountains, although not all of these can be located today[583]. Carl Schuchhardt was the first researcher to hypothesize a visual network in the region. He discovered, for example, that information on fleet movements in the area of the Arginusae Islands near Kane could be transmitted as signals to Pergamon

571 Reu et al. 2011, 3435.

572 Becker et al. 2020; Yang et al. 2021.

573 Williamson 2016; Williamson (in press)b; Williamson (in press)a.

574 Wulf 1999; Agelidis 2009; Pirson et al. 2011, 123–126; Agelidis 2012; Pirson 2012a, 219–225; Ateş 2014; Williamson 2014a; Williamson 2016; Pirson 2017; Pirson – Ludwig (in press).

575 Marek – Frei 2017, 238–391.

576 Pirson 2012a, 225–229.

577 Müller 2010.

578 E.g., Polybius 16.1.

579 Ma 2013, 73.

580 Pirson 2016, 175–176 (E. Laufer); Pirson 2018, 152–157 (S. Feuser – E. Laufer); Laufer 2020.

581 Pirson 2016, 181–184 (E. Laufer); Pirson 2018, 157–161 (S. Feuser – E. Laufer); Laufer 2020.

582 Schuchhardt 1887, 1209–1211; Conze 1912 100–101. 108–109 (C. Schuchhardt).

583 Diest 1889, 8.

via the fortresses on Kavaklık Tepe (Kabalyk)[584], Hatipler Kalesi[585] and Kalarga Tepe/Teuthrania[586]. Wolfgang Radt takes up the idea of a potential Hellenistic protection and communication system again in the context of a watchtower near Kapıkaya few kilometers north of Pergamon[587]. He also discusses the fortifications on the Kane Peninsula and concludes that this 'watch and warn' system secured a smaller area than the actual borders of the Pergamene territory. In a contribution on the Hellenistic fortification of Pergamon and its regional strategic importance, Manfred Klinkott adopts the hypothesis of an extensive system of watchtowers and small fortresses and discusses their landscape positioning and orientation towards the plain of the Bakırçay River[588]. A network of military installations controlled from Pergamon was also assumed by Felix Pirson, in the context of Hellenistic fortresses in the vicinity of Atarneus[589]. Martin Zimmermann linked fortified settlements on the hills of the Bakırçay Plain and the adjacent mountains to the military protection of the *chora* of Pergamon[590], but at the same time, he argues against the military function of many sites and interprets them as centers of agricultural estates, so-called *Turmgehöfte*[591]. Due to the fortified character of the sites and their mostly spectacular view one cannot rule out an additional function for (local) surveillance. We therefore include these places in our analyses for a start, allowing for a more complex interpretation of their function.

Pergamon itself was protected by its location on the city hill combined with a city wall[592]. 10 km southwest of Pergamon a Hellenistic fortification was situated on the prominent Eğrigöl Tepe/Halisarna[593] in the plain (Figs. 5.3.1, 5.3.2). The highest and most prominent elevation in the plain west of Pergamon was Kalarga Tepe/Teuthrania (Figs. 5.3.1, 5.3.2). It is assumed that the Hellenistic fortification on the summit served for the military protection of the plain due to its exceptional location. A smaller fortification from the Hellenistic period is situated on Memeli Tepe[594], a less imposing hill just 5 km west of Kalarga Tepe/Teuthrania. Another 5 km to the north a fortification is located on Dede Tepe[595] in the southern foothills of the Kozak Mountains. The settlement of Atarneus[596], already fortified in Hellenistic period, was also located in the southwestern foothills of the Kozak Mountains at the northwestern entrance of the Bakırçay

584 Schuchhardt 1887, 1210; Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 212–213 (M. Zimmermann); Zimmermann et al. 2015, 213.

585 Conze 1912, 118 (C. Schuchhardt); Pirson 2010, 181–182 (M. Zimmermann); Pirson 2011, 154–158 (M. Zimmermann); Pirson 2013, 119–121 (A. Matthaei); Zimmermann et al. 2015, 213–214.

586 Conze 1887, 149–160; Schuchhardt 1887, 1209–1210; Pirson 2013, 117–119 (A. Grüner); Zimmermann et al. 2015, 211–212; Williamson 2016.

587 Radt 2016, 21.

588 Klinkott 1999, 204.

589 Pirson 2012a, 229.

590 Zimmermann et al. 2015, 211.

591 Pirson 2008b, 121–122 (M. Zimmermann); Pirson 2012b, 211–213 (M. Zimmermann). *Turmgehöfte* in general: e.g., Haselberger 1979; Konecny 1997; Pimouguet-Pédarros 2000; Lohmann 2015.

592 On the city wall most recently Lorentzen 2010; Lorentzen 2014; Pirson 2017. On Pergamon in general: Pirson – Scholl 2014; Radt 2016; Pirson 2017; Scholl – Schwarzmaier 2018 among others.

593 Conze 1912, 116–117 (C. Schuchhardt); Pirson 2012a, 225–226; Pirson 2012b, 215–216 (M. Zimmermann); Zimmermann et al. 2015, 211–212.

594 Pirson 2009, 181–182 (M. Zimmermann); Pirson 2010, 181–182 (M. Zimmermann).

595 Dörpfeld 1928, 154–156; Pirson 2012b, 215–216 (M. Zimmermann); Zimmermann et al. 2015, 212.

596 Conze 1912, 120–121 (C. Schuchhardt); Pirson 2012b, 208–211 (M. Zimmermann); Pirson – Zimmermann 2014, 153–160; Zimmermann et al. 2015, 193–207.

Fig. 5.3.2 View from the western slope of the Acropolis of Pergamon with the present-day city of Bergama and the location of the fortresses on Büyüksofulu Tepe, Serhat Tepe, Eğrigöl Tepe/Halisarna, and Kalarga Tepe/Teuthrania.

Plain. On the opposite side of this narrow passage a small fortress (Site 2011/DIK01)[597] was situated in the northern foothills of the Kara Dağı Mountains. Both the fortified settlement of Hatipler Kalesi and the small fortress at Deliktaş[598] in the western area of the Kara Dağı Mountains face the Bakırçay Plain. As previously mentioned, early researchers identified many other fortifications scattered throughout the Kane Peninsula. Many must be considered lost today, with the exception of a few recently rediscovered sites in the western and southern areas of the Kara Dağı Mountains: In the south of this peninsula, there are two probable fortifications near Pitane (Site 2017/PIT01)[599] and on Yazılı Taş Tepe[600], as well as the fortified settlement of Kemikliburun[601] and the watchtower above present-day Denizköy (Site 2017/05)[602]. The two sites of Söğütlü Kalesi[603] and Asarlık Tepe[604] are located on plateaus of Kara Dağı. So far, they have been interpreted as centers of agricultural estates, but with their expansive and strategic views, a military securing function should not be ruled out. Remains of another fortification were found 4 km south of Bademli (Site 2017/06)[605] near Asarlık Tepe. The most elevated fortification in the Kara Dağı Mountains is located on Kavaklık Tepe. This site offers an impressive view both to the coast and to the Bakırçay Plain. Besides several bays and landing sites, two harbor cities were located along the coast of the Kane Peninsula in the Hellenistic period: Kane in the northwest of the peninsula and Pitane on a headland in the south. In both places a city wall can be traced for the Hellenistic period. The same applies to the harbor city of Elaia[606], which as the main harbor of the Attalids had the greatest importance for

597 Zimmermann et al. 2015, 213.

598 Conze 1912, 100–101 (C. Schuchhardt); Pirson 2010, 168. 182 (M. Zimmermann).

599 Unpublished project report 2017.

600 Pirson 2019, 120 (B. Ludwig).

601 Pirson 2019, 118–120 (B. Ludwig).

602 Pirson 2018, 161–164 (S. Feuser – E. Laufer).

603 Conze 1912, 112 (C. Schuchhardt); Pirson 2012b, 211–212 (M. Zimmermann); Zimmermann et al. 2015, 213.

604 Schuchhardt 1887, 1210; Conze 1912, 119 (C. Schuchhardt); Pirson 2012b, 212–213 (M. Zimmermann); Zimmermann et al. 2015, 213.

605 Pirson 2018, 163–164 (S. Feuser – E. Laufer).

606 Most recently Pirson et al. 2015; Feuser et al. 2018; Seeliger et al. 2019; Feuser et al. 2020.

Pergamon[607]. The harbor city was located on a strategically important place at a narrow point between the foothills of the Yunt Dağı Mountains and the coast at the southwestern entrance to the Bakırçay Plain. The harbor and the coastal road running through this narrow space were additionally secured by the fortress on Sakarkaya[608] 3.3 km southeast of Elaia. Similar fortresses on Zindan Kayası[609] and Gavur Evleri[610] were located in side valleys a few kilometers south of Sakarkaya. These types of fortifications are also known from other valleys in the northwestern foothills of the Yunt Dağı Mountains in Hellenistic period. The Kuyulu Kaya[611] fortress was located on a high rock in the middle of the Tekkedere Valley. A similar situation can be observed in the small and narrow Değirmendere Valley where a small fortress (Site 2017/04)[612] was situated on a hill near present-day Karahıdırlı. In contrast, the fortresses on Büyüksofulu Tepe[613] and Serhat Tepe[614] were both located on high peaks in the northwestern Yunt Dağı Mountains, offering a wide view of the Bakırçay Plain and the surrounding mountains.

The landscape in this area near Pergamon was thus punctuated with watchtowers and strongholds. Even if they were not all simultaneously occupied, their frequency (cf. Fig. 5.3.1), indicates an intensive web of defense systems throughout the landscape.

The integration of visibility-based approaches into the study of Pergamon and its micro-region however, is neither new nor exclusive to GIS. C. Schuchhardt already considered visibility as a location factor for sites on the Kane Peninsula more than a century ago[615]. Vincent J. Scully and Wolfram Hoepfner outlined visual axes between major Hellenistic buildings on the city hill, the monumental tumuli in the plain, and the surrounding landscape[616]. Visual connections between the city hill of Pergamon and the extra-urban sanctuaries at Mamurt Kale and Kapıkaya were observed by Alexander Conze and Paul Schazmann as well as Klaus Nohlen and W. Radt[617]. Based on this observation, Ulrike Wulf correlated the orientation of the city's road system with visual axes between city hill and sites in the surroundings[618]. These relations were most recently revised by F. Pirson[619]. His studies of Pergamon's territory as a perceptual space[620], or its role as the visual-aesthetic center of the dominion[621], were extended by C. G. Williamson[622] by the concept of a 'visual region' for the lower Bakırçay Plain and GIS-based visibility analyses. Most recently,

607 Pirson 2014; Pirson et al. 2015; Feuser et al. 2018; Feuser et al. 2020.

608 Pirson 2010, 201; Pirson 2011, 172–173.

609 Pirson 2010, 201; Pirson 2012b, 222–225; Pirson 2017, 53.

610 Conze 1912, 114–115 (C. Schuchhardt); Pirson 2010, 200–201.

611 Pirson 2019, 115–116 (B. Ludwig); Pirson 2020, 210–212 (B. Ludwig).

612 Pirson 2018, 167–168 (B. Ludwig – F. Pirson).

613 Pirson 2019, 117–118 (B. Ludwig).

614 Pirson 2012b, 213–214 (M. Zimmermann); Pirson 2013, 121–122 (A. Matthaei); Zimmermann et al. 2015, 212–213.

615 Schuchhardt 1887.

616 Scully 1979, 194–198; Hoepfner 1990, 282.

617 Conze – Schazmann 1911 (Mamurt Kale); Radt 1978, 71 (Kapıkaya).

618 Wulf 1999.

619 Pirson 2017, 61–62.

620 Pirson 2008a, 45.

621 Pirson 2012a, 219–225.

622 Williamson 2016.

such analyses have been applied by F. Pirson and Bernhard Ludwig[623] in the study of urban-landscape interactions and by Daniel Knitter and B. Ludwig[624] to demonstrate a completely reproducible work-flow in landscape archaeological research.

The examples mentioned here illustrate that seeing and being seen can be associated with religious ideas or political motives. In this study, however, we focus on the need for surveillance, communication, or control and its impact on the positioning of places within a landscape.

3. Archaeological and Topographic Data

Archaeological data used in this study includes a data set of 27 archaeological sites assembled and published through various survey projects managed by the Pergamon Excavation Project[625].

The analyses conducted in this study are based predominantly on topographic data (derived from a digital elevation model DEM). These models usually represent the present-day terrain surface and only in rare cases can the ancient topography be reconstructed. Nevertheless, modern elevation models form the basis for these analyses and their horizontal and vertical accuracy as well as their resolution significantly influence the calculated results. Therefore, it is essential to mention this information and take them into account when comparing and interpreting the results.

In this study we use an open-access DEM to guarantee reproducibility. The elevation data are provided by the EU Copernicus project as EU-DEM v1.1. This provides a digital surface model that fuses SRTM and ASTER GDEM data using a weighted average approach. The EU-DEM v1.1 has a pixel resolution of 25 × 25 m and a vertical accuracy of 7 m[626].

4. Methods

This study follows a landscape approach most recently proposed by Sylvian Fachard[627] and is based upon quantitative spatial analyses to assess the networking potential of rural fortifications and Pergamon's ability to control its micro-region. These phenomena depend on numerous factors, necessitating an approach that integrates analyses from the perspective of topography, visual perception, and mobility.

All analyses conducted in this study are based solely on open-source software. Basic processing, reading, writing, and reprojection of spatial data are conducted using GDAL[628]. R software is used as general entry point to more advanced geomorphometric methods conducted via GRASS GIS[629].

623 Pirson – Ludwig (in press).

624 Knitter – Ludwig 2021.

625 See also note 565.

626 Copernicus Programme 2022a.

627 Fachard 2016a; Fachard 2016b.

628 GDAL/OGR Contributors 2021.

629 GRASS Development Team 2017; R Core Team 2021. For our computational code and further details, see Knitter et al. 2021.

4.1 Relief

4.1.1 Topographic Position Index

The Topographic Position Index (TPI) is a measure of the difference between the elevation of a point on a DEM and the mean elevation of the neighboring cells within a predetermined radius[630]. In this study, the point represents the location of the site and the neighboring cells represent the landscape. Sites with positive TPI values are located higher than the average of their surrounding landscape and sites with negative TPI values are located lower, meaning that positive TPI values indicate an exposed location within a landscape while negative TPI values indicate a valley or depression-like location. TPI values around 0 correspond to flat areas or constant slopes. Using this method, we can classify the topographic positions of the sites relative to the local landscape. This allows us to draw conclusions about the individual function of a site. And by comparison with other sites and results, we may be able to identify commonalities, connections, and relationships that indicate a higher-level role within a system or network.

For the calculation of the TPI we employ the r.neighbors tool in GRASS GIS that calculates each cell of a raster file (the DEM) as a function of the values assigned to the cells around it (i.e., in its user-defined neighborhood). In our case, the function is the difference from mean elevation between the pixel and the mean of all pixels in its neighborhood. Small-scale topographic features can be revealed using small neighborhood sizes and large-scale features such as ridges or valleys can only be highlighted through large neighborhood sizes. This illustrates the scale dependence of TPI. The term scale can have two meanings that should be considered. On the one hand, it refers to the extent in space, i.e., the size of neighborhood, and on the other hand, to the resolution, in this case the pixel size of the DEM[631]. Marzieh Mokarram and Dinesh Sathyamoorthy described scale as "the window of perception, and hence, it has a direct influence on the landform type on a specific location"[632]. In this study, we want to investigate both the local topography surrounding each site and its position within the landscape from a more general perspective. To account for both scenarios, we calculate the TPI with both a neighborhood size of 5 cells (125 m) and 11 cells (275 m).

4.1.2 Geomorphons

In order to put our site-based investigations into the wider topographic context, we additionally compute geomorphons. This concept was introduced by Tomasz F. Stepinski and Jaroslaw Jasiewicz, who define geomorphons as "a relief-invariant, orientation-invariant, and size-flexible abstracted elementary unit of terrain"[633]. Thus, geomorphons are much less sensitive to scale. Instead of a fixed neighborhood size, e.g., a specific number of immediate neighboring cells, this method uses pixels determined from the line-of-sight principle along the eight compass directions. The search radius represents the maximum allowable distance for calculation of their zenith and nadir angles. All pairs of zenith and nadir angles are converted into a pattern and assigned to a geomorphon[634]. Using the r.geomorphon algorithm in

630 Cf. Weiss 2001; Lindsay et al. 2015.

631 Goodchild 2011, 5.

632 Mokarram – Sathyamoorthy 2018, 653.

633 Stepinski – Jasiewicz 2011, 109.

634 Jasiewicz – Stepinski 2013, 152.

GRASS GIS the ten most common landform types (flat, summit, ridge, shoulder, spur, slope, hollow, foot slope, valley, and depression) were derived from the DEM. We set the flatness threshold to 1 degree and the flatness distance to 100 m to take care of modern noise, e.g., caused by small dams for traffic and agricultural purposes. To obtain a differentiated result, we use five different search radii: 100 m, 500 m, 1,000 m, 1,500 m, and 2,000 m. These represent both a local and a regional perspective.

4.2 Visibility

Visibilities are highly dependent on the topography of a landscape. Prominent sites, for example, rise out of the landscape, are visible from a distance, and are "related to visual and physical control"[635]. Visibilities and the relative topographic position of archaeological sites are thus closely related and must be studied together.

The study of visibility has numerous applications in archaeological research today[636]. Especially in landscape archaeology, visibility is considered a structuring element of past landscapes and important factor in the location of sites[637]. Since the emergence of GIS software, the application of visibility analysis is a regular feature of many archaeological studies. As long as the difficulties in the application, both in the computational process and in the interpretation of the results, are not disregarded, computer-based visibility analyses are supportive tools in the study of ancient human-environment relationships.

4.2.1 Single Viewsheds of Each Site

Viewsheds are the areal extent of visibility from a designated place. In GIS one can calculate a viewshed based on the surface values in a digital elevation model (DEM). Using a defined observer location, the viewshed function will assign a value of 1 or 0 to each raster cell. The result is a binary map with the values 'visible' and 'not visible'. In GIS analyses the observer's field of vision is infinite, restricted only by the extent of the applied terrain model or curvature of the earth, although other parameters can be applied, such as observer or target height, visual range, or scope. In practice, however, seeing and recognizing is determined, for example, by the size of the object, the contrast to its surroundings, its brightness, color and shape. To compensate for this, David Wheatley and Mark Gillings[638] introduced the Higuchi viewshed analysis[639] to archaeological research, which classifies the range of visibility to distance values. Dennis Ogburn[640] further adapted this method by integrating environmental (haze, light conditions, etc.) and object-related (size, contrast, etc.) factors into the calculation. In these 'fuzzy' viewsheds, degrees of visibility between 1 (clearly visible) and 0 (not visible) are assigned. However, visual perception is a complex phenomenon that cannot yet be fully modeled in GIS. Most of the common

635 Llobera 2001, 1007.

636 E.g., Brughmans et al. 2018; Fábrega-Álvarez – Parcero-Oubiña 2019; Lewis 2020b among many others, and with an overview and further reading Gillings – Wheatley 2020.

637 Doneus 2013, 301–306.

638 Wheatley – Gillings 2000.

639 Higuchi 1983.

640 Ogburn 2006; also Llobera 2007.

issues were summarized by D. Wheatley and M. Gillings[641] and should be considered in the calculation, but especially discussed in the interpretation process of visibility analyses.

We compute the viewsheds using the r.viewshed algorithm in GRASS GIS. Generally, they are calculated from a single observation point. This approach however, is unsuitable for larger sites such as hilltops or fortified settlements. One alternative is to create random points in a defined area surrounding the site and calculate a viewshed for each of these points. Another alternative, that integrates the assumption of several hilltop sites, is to use the most exposed points as defined by the TPI values in the surrounding of a site. We followed this approach and used a radius of 100 m around a site as search radius. Our basic observer height is set to 10 m, taking into account both the observer's eye level and the potential height of towers. For eye level, we refer to Wolf-Rüdiger Teegen[642] who gives an average height of 1.52 m (± 3 cm) for women and 1.57 m (± 3 cm) for men in Hellenistic-Roman Pergamon. For the height of towers, we refer to John H. Young, Josiah Ober and Hans Lohmann[643] and consider 10 m for both tower and observer's eye level to be a conservative height assumption. Since we cannot exclude smaller or larger tower heights due to the often-poor preservation of the archaeological sites we additionally include observer heights of 5 m, 7.5 m, 12.5 m and 15 m in our study. Another parameter is the maximum calculation radius around each site. This maximum range of visibility is set at 40 km, based on known local conditions – for example, the Mediterranean Sea, at ca. 30 km away, may be seen from the city hill of Pergamon but only during very clear atmospheric conditions. Consequently, all the fortified sites are within the search radius, but whether they would actually be visible or not must be assessed in the second step, based on the results and the authors' own experience from the field ('ground-truthing').

To consider the decreasing visibility of objects with distance, i.e., Higuchi (see above), we calculate the visible areas by the distance from the observer location, using a triangular fuzzy membership function to create Higuchi-like viewsheds with values ranging between 1 (visible at the location of the site) and 0 (theoretically visible but too distant to be recognizable), with 40 km as maximum radius. We employ the R package FuzzyLandscapes for these calculations[644].

4.2.2 A Cumulative Viewshed of All Sites

We assume that the fortifications and fortified settlements in the western part of the Pergamon Micro-Region form a potential network based on visibility. Combining the calculated viewsheds into a cumulative viewshed[645] of all the sites gives an impression of the entire area that could be visually monitored; the Higuchi-like viewsheds moreover indicate the quality of visibility in different areas, and the importance of favorable atmospheric conditions. It is also possible to identify areas that either could not be viewed or where there could theoretically be other strongholds that are still undiscovered.

641 Wheatley – Gillings 2000.

642 Pirson 2020, 234–237 (W.-R. Teegen); cf. Angel 2013 for the Hellenistic Mediterranean.

643 Young 1956; Ober 1987; Lohmann 1993; Lohmann 2015.

644 Hamer – Knitter 2018.

645 Wheatley 1995.

4.2.3 Line-of-Sight Connections/ Inter-Visibility Network

Mutual communication is essential for a potential surveillance and fortification network and can be ensured through connections of inter-visibility. By deliberately placing or using specific sites within the landscape, inter-visibility connections are created and sites are linked together, creating a network based on visibility. Line-of-sight analysis assesses these inter-visibility connections and obstacles along a given line between two locations, and is therefore a useful tool. In performing the analysis, we set both the observer and target heights to 5 m, 7.5 m, 10 m, 12.5 m, and 15 m according to our previously mentioned assumptions (see 4.2.1).

4.2.4 Natural Visuality

To gain insights into the relationship between visibility in the landscape and the location of the fortified places, we examine the natural visuality of the western micro-region. The term 'visuality' implies the qualitative potential of visibility provided by certain areas and the degree to which the studied places were themselves naturally prominent in the landscape, as well as the views which they afforded[646]. It also references the area of visual interaction between those places. Connected with this is the concept of 'visual regions', areas that are included within a single frame of viewing which implicitly gives them a logical coherence, at least in the eyes of the beholder[647]. This visual sense of belonging readily extends towards a conceptualization of territory and governance, as Aristotle had prescribed[648].

For the area of the Pergamon Micro-Region this extends beyond land. A distinctive feature of this area is the long coastline to the west. Given the maritime and naval activities, this was certainly not a boundary for historical interaction processes and therefore we incorporated the offshore coast in our area of study. However, the range of visibility widely differs between land and sea surfaces and so we generated 9,999 randomly distributed on-shore and 2,000 off-shore observation points in the study area for our calculations of cumulative viewsheds. This allows us to better identify and interpret phenomena along the coastline that arise from this edge location. To compensate for edge effects[649], we extended the modeling area, corresponding to the bounding box of the catchment-based complementary region presented by Julian Laabs and D. Knitter[650] that was further extended by 10 km on each side. For visualization reasons the maps show a smaller area.

4.3 Isochrones

A prominent or elevated position within the landscape can increase the ability to survey the environment and communicate over greater distances, but at the same time the accessibility of the monitored area must be ensured to control this particular area. Movement through the immediate vicinity of the sites thus constitutes another factor to be considered in this study. Movement usually takes place along paths, but their traces in the study area are very sparse. In order to determine the potential area of influence

646 Llobera et al. 2010.

647 Williamson 2014b; Williamson 2016 with references.

648 Aristotle, Politica 7.1327a.

649 Gillings – Wheatley 2020.

650 Laabs – Knitter 2021 See Knitter et al. 2021 for the data and corresponding code.

through movement, we have calculated isochrones[651]. They show the anisotropic cumulative time of moving from a defined location, comparable to least-cost paths[652] without a defined target. The resulting isochrones can be mapped indicating an area that can be reached in a given timeframe. This assists in (a) estimating travel times from the fortifications through their immediate surroundings, in (b) assessing where lack of inter-visibility could be bridged with movement between fortifications to communicate, and in (c) determining whether and to what extent strategic places and important areas in the Pergamon Micro-Region could be reached by one of the fortifications within a certain time.

We use the r.walk algorithm in GRASS GIS for the calculations. The cost of movement is determined by the slope and different cost parameters, affecting the movement speed. While the original algorithm employs parameters defined by Eric Langmuir[653], we use updated values following analyses of Joaquín Márquez-Pérez et al. as well as Ian J. Irmischer and Keith C. Clarke[654] to calculate cumulative movement costs, i.e., time in seconds it takes to walk for 1 meter a flat surface (1/walking speed): 0.8 (r.walk default: 0.72); additional walking time in seconds, per meter of elevation gain on uphill slopes: 5.0 (r.walk default: 6.0); additional walking time in seconds, per meter of elevation loss on moderate downhill slopes: -3.25 (r.walk default: 1.998); additional walking time in seconds, per meter of elevation loss on steep downhill slopes: -5.5 (r.walk default: -1.998).

5. Results

5.1 Geomorphometric Analyses

5.1.1 Topographic Position Index

The Topographic Position Index provides information on the relative topographic position of the fortifications. Positive values indicate exposed or prominent locations, while negative values indicate valleys or hollows. As may be expected, fortresses will in most cases be located in exposed or well defensible locations. This is demonstrated in the calculated TPI values (Fig. 5.3.3).

All but a few of the values are positive. Kalarga Tepe/Teuthrania has by far the highest value, which can be explained by its location in the middle of the western lower Bakırçay Plain. Its exceptional location, prominence and importance for the region between Pergamon and the coast have already been recognized[655]. More sites have positive values, but there are also some with negative values that deserve attention. The harbor cities of Elaia, Pitane, and Kane have negative values, due to their location in bays with little exposure. Pitane, located on a headland at the southern Kane Peninsula, should be more exposed than the other harbors, but the difference in elevation between the headland and the sea is negligible. With the exception of site 2017/06 near Bademli, all other sites with low TPI values are located on small hills in very narrow and deeply incised valleys of the Yunt Dağı Mountains. This topographical

651 Becker et al. 2017; Oltean – Fonte 2021.

652 On the application of least-cost path analyses in archaeological research, see most recently Herzog – Schröer 2019; Parcero-Oubiña et al. 2019; Verhagen et al. 2019; Herzog 2020 among many others. For the calculation of least-cost paths in the Pergamon Micro-Region, see Ludwig 2020; Knitter – Ludwig 2021.

653 Langmuir 1984.

654 Márquez-Pérez et al. 2017; Irmischer – Clarke 2018.

655 Williamson 2016.

situation is the reason why the TPI value decreases significantly with larger radii, especially at the Gavur Evleri.

In short, the Topographic Position Index generally appears to correctly represent topographic locations, but we need additional data and information to validate this observation.

Place name	TPI		Geomorphons				
	125 m	275 m	100 m	500 m	1000 m	1500 m	2000 m
Kalarga Tepe/Teuthrania	4.459	20.750	spur	summit	summit	summit	summit
Site near Dikili (Site 2011/DIK01)	2.553	13.203	ridge	summit	summit	summit	summit
Asarlık Tepe	2.392	12.445	ridge	summit	ridge	ridge	ridge
Dede Tepe	2.310	12.566	ridge	ridge	summit	summit	summit
Sakarkaya	2.252	12.733	spur	ridge	ridge	ridge	ridge
Serhat Tepe	2.121	11.079	spur	ridge	ridge	ridge	ridge
Pergamon	1.992	10.656	spur	summit	summit	summit	summit
Eğrigöl Tepe/Halisarna	1.950	10.797	summit	summit	summit	summit	summit
Büyüksofulu Tepe	1.846	10.492	spur	summit	summit	summit	summit
Hatipler Kalesi	1.403	8.241	spur	summit	summit	summit	summit
Atarneus	1.354	8.035	spur	summit	summit	summit	summit
Site near Pitane (Site 2017/PIT01)	1.252	6.547	slope	spur	spur	spur	spur
Memeli Tepe	1.162	5.320	ridge	ridge	summit	ridge	ridge
Site near Denizköy (Site 2017/05)	0.902	5.276	slope	spur	spur	spur	spur
Deliktaş	0.897	4.639	spur	spur	spur	spur	spur
Kavaklık Tepe	0.610	3.614	slope	ridge	summit	summit	summit
Yazılı Taş Tepe	0.584	2.751	slope	slope	slope	slope	slope
Söğütlü Kalesi	0.526	2.760	spur	ridge	slope	slope	slope
Pitane	0.398	2.357	ridge	summit	summit	summit	summit
Kemikliburun	0.343	2.021	slope	slope	ridge	ridge	ridge
Zindan Kayası	0.319	0.430	slope	hollow	hollow	hollow	hollow
Kuyulu Kaya	0.291	0.516	slope	hollow	valley	valley	valley
Elaia	0.245	1.167	spur	slope	slope	hollow	hollow
Kane	0.207	0.763	footslope	footslope	slope	slope	slope
Site near Karahıdırlı (Site 2017/04)	0.001	-0.555	slope	hollow	valley	valley	valley
Site near Bademli (Site 2017/06)	-0.253	-1.487	slope	spur	slope	slope	slope
Gavur Evleri	-0.379	-2.286	slope	valley	valley	valley	valley

Fig. 5.3.3 Results of TPI and geomorphon analyses sorted in descending order by TPI 125 m.

5.1.2 Geomorphons

Geomorphons were calculated for the study area to analyze the sites in their wider topographic context. Since the investigated sites are located in a very heterogeneous landscape and to represent both a local and a regional perspective, we set five different search radii: 100 m, 500 m, 1,000 m, 1,500 m, and 2,000 m. The results show that there are almost no differences between 1,000 m, 1,500 m, and 2,000 m (Fig. 5.3.3). We can identify high hills in the flat and wide western lower Bakırçay Plain (e.g., Eğrigöl Tepe/Halisarna or Kalarga Tepe/Teuthrania) with values between 100 m and 1,000 m. The location of small hills in narrow valleys (e.g., Kuyulu Kaya or Site 2017/04 near Karahıdırlı) is not well represented.

From the perspective of a regional surveillance or communication system, information can be derived from the combination of TPI and geomorphons (Fig. 5.3.3). Half of the sites are located in elevated positions within the landscape with TPI values above 1 (125 m) and 5 (275 m) and corresponding geomorphons (summit, ridge, spur). They have a high potential to form a higher-level system. These sites also predominantly have direct proximity to the western lower Bakırçay Plain (Fig. 5.3.1). The other half of the sites has a low TPI and is located in more differentiated topographic units. Their potential to be part of a higher-level system is lower and they may have had more local functions.

The advantages of combining multiple geomorphologic analyses can be seen when considering the harbor places of Elaia, Pitane, and Kane. If the TPI indicated little difference in values despite their different locations in bays or on a peninsula, the result of the geomorphons is more meaningful (Fig. 5.3.3). The particular position of Pitane on a peninsula on the southern coast of the Kara Dağı Mountains is highlighted by its assignment to the topographic unit of ridge and summit. This result emphasizes the exposed location within the area, which is relevant to the study of monitoring and control.

5.2 Visibility Analyses

5.2.1 Single Viewsheds of Each Site

The individual viewsheds of each location indicate which areas in their surroundings could be seen and monitored. Orientation, size and range of the visible area allow conclusions to be drawn about the potential for a surveillance function. Higuchi viewsheds also provide information on the quality of visibility.

The viewshed of Pergamon shows a good visibility of the southern Bakırçay Plain up to the foothills of the Yunt Dağı Mountains (Fig. 5.3.4). The view extends to the coast and the Kara Dağı Mountains, but the quality of visibility decreases significantly. However, fortresses such as Kalarga Tepe/Teuthrania, Eğrigöl Tepe/Halisarna or Serhat Tepe are still located in the highly visible area (Fig. 5.3.2).

The visible area of Kalarga Tepe/Teuthrania, the fortress on a prominent hill in the middle of the plain, is exceptionally extensive (Fig. 5.3.5). Due to its special position, parts of the eastern lower Bakırçay Plain, Pergamon, the entire western lower Bakırçay Plain, the surrounding mountain ranges, and parts of the coastline between Elaia and Pitane are visible. The fortress on Serhat Tepe has a similarly extensive visible area (Fig. 5.3.6). From this point, parts of the Yunt Dağı Mountain range with its side valleys leading to the plain, the transition between the mountains and the plain, can be monitored. This is especially true for the intramontane basin framed by the forts on Serhat Tepe and Büyüksofulu Tepe

(Fig. 5.3.6), an intensively used agricultural area in the immediate vicinity of Pergamon[656]. Also, smaller side valleys could apparently be monitored by their own fortresses, which could serve as a retreat in troubled times. A good example of this is the viewshed of Kuyulu Kaya (Fig. 5.3.7). The visible area is almost exclusively limited to the Tekkedere Valley. The fortress near Karahıdırlı (2017/04) in a narrow valley in the foothills of the Yunt Dağı Mountains has a similarly small visible area (Fig. 5.3.7). It probably had a local function, such as monitoring or controlling the route that led from the mountains through the valley to the Bakırçay Plain and Pergamon[657]. Eğrigöl Tepe/Halisarna, on the other hand, has already been interpreted as an outpost of the city monitoring and controlling of the main traffic route through the western lower Bakırçay Plain and an ancient bridge over the ancient Kaikos River next to the hill[658]. The viewshed from this place, covering large parts of the plain, supports this hypothesis (Fig. 5.3.8). Further visual relations can be identified along the coastline. The viewsheds from Sakarkaya (Fig. 5.3.9) and the fortress near Pitane (2017/PIT01) (Fig. 5.3.10) are both oriented toward the Gulf of Çandarlı and have a direct relationship to the ancient harbors of Elaia and Pitane. Due to these visual relationships and their positioning on exposed locations, a monitoring or control function for these sites was outlined earlier[659]. A surveillance relationship to individual bays, which served as temporary landing sites along the coast[660], can also be seen in the viewshed from the fortress near Denizköy (2017/05) (Fig. 5.3.11).

For Asarlık Tepe and Söğütlü Kalesi in the western Kara Dağı Mountains no convincing interpretation as a watchtower or as part of an agricultural estate has been presented so far. The viewshed from Söğütlü Kalesi is limited to a few small and disjointed areas in the southwestern Kara Dağı Mountains (Fig. 5.3.12). In contrast, the visible area of Asarlık Tepe includes not only Kane but also the Arginusae Islands and the only coastal strip along the Kane Peninsula that does not consist of steep cliffs (Fig. 5.3.12). Based only on their viewsheds, we can assume a surveillance function for Asarlık Tepe and a retreat or agricultural character for Söğütlü Kalesi. The fortress on Kavaklık Tepe is also located in the Kara Dağı Mountains, but has very different visual characteristics. The viewshed illustrates the commanding view, which covers the coastline in the area of Kane and the Arginusae Islands, the coast north of Atarneus, and large areas of the Bakırçay Plain (Fig. 5.3.13). The view across the mountains both into the plain and to the coast, already highlighted by the place's discoverers, clearly speaks of geostrategic motives in the selection of this spot.

656 Pirson 2020, 212–214 (B. Ludwig). 220–223 (F. Pirson). 223–227 (F. Becker – D. Knitter – X. Yang – B. Schütt).
657 Cf. Ludwig 2020.
658 Pirson 2012a, 225–226.
659 Pirson 2012a, 226; Ludwig 2022.
660 Ludwig 2022.

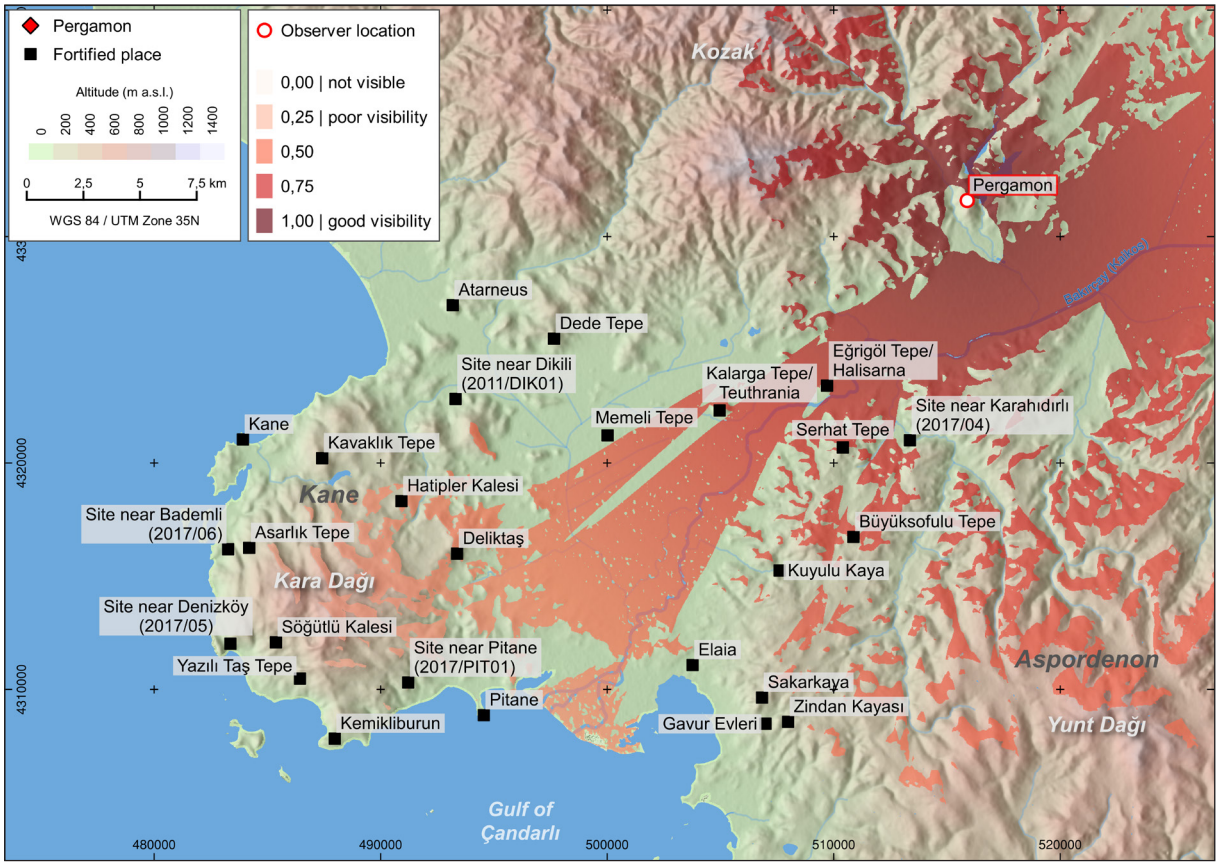

Fig. 5.3.4 Higuchi viewshed from Pergamon (10 m observer height).

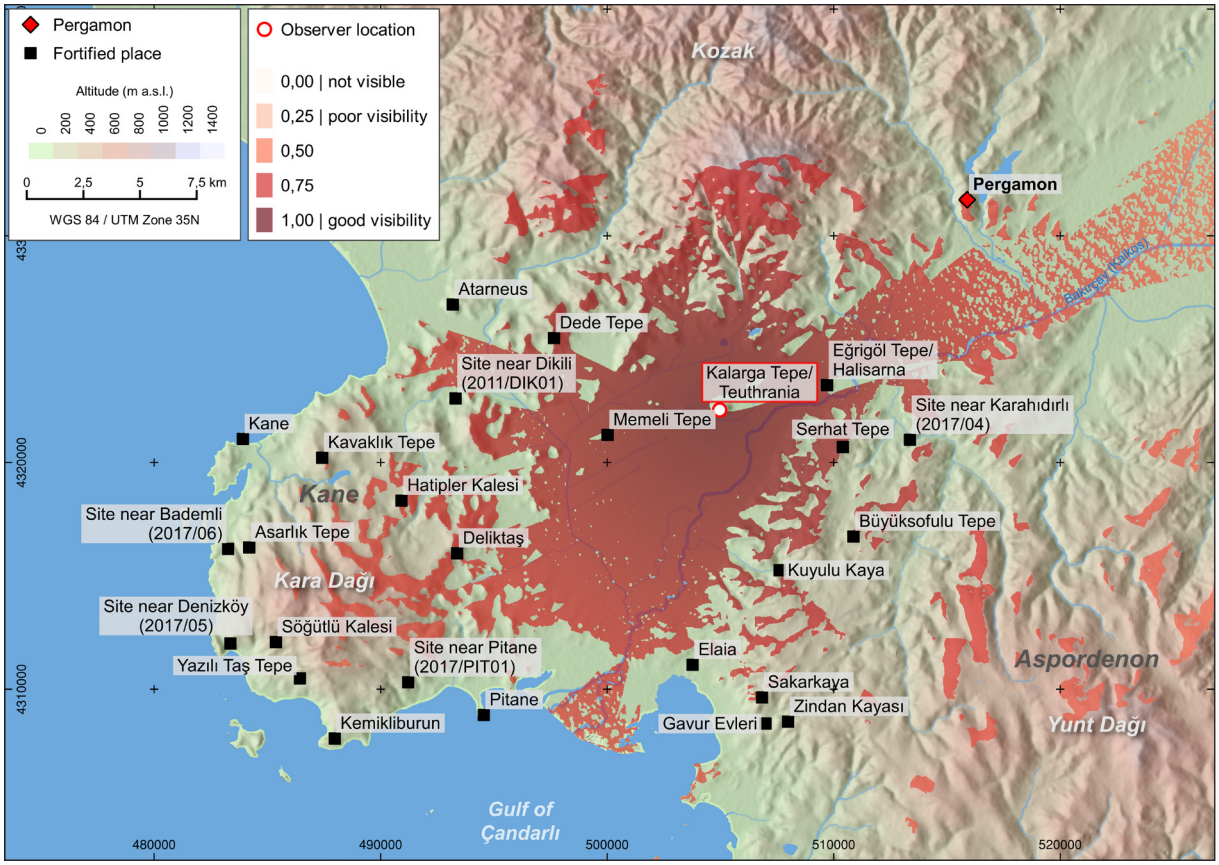

Fig. 5.3.5 Higuchi viewshed from Kalarga Tepe/Teuthrania (10 m observer height).

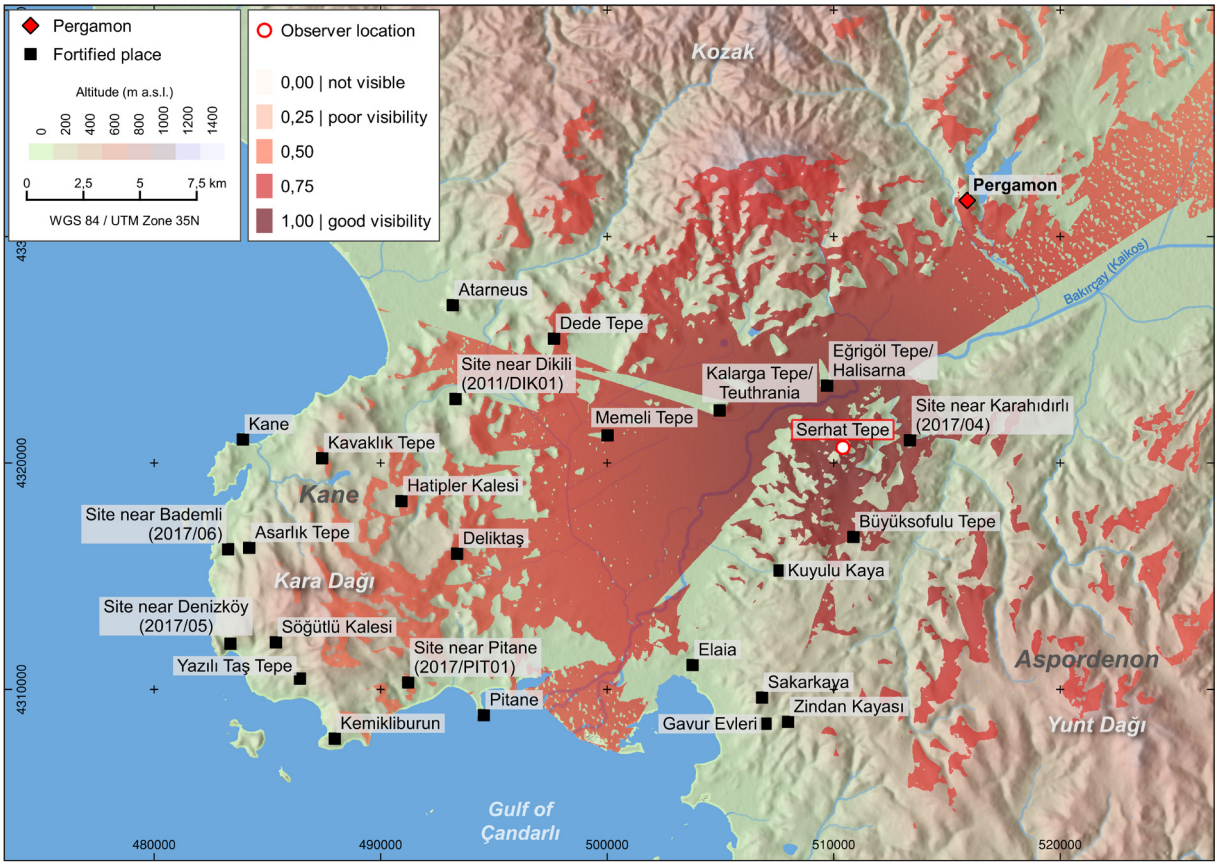

Fig. 5.3.6 Higuchi viewshed from Serhat Tepe (10 m observer height).

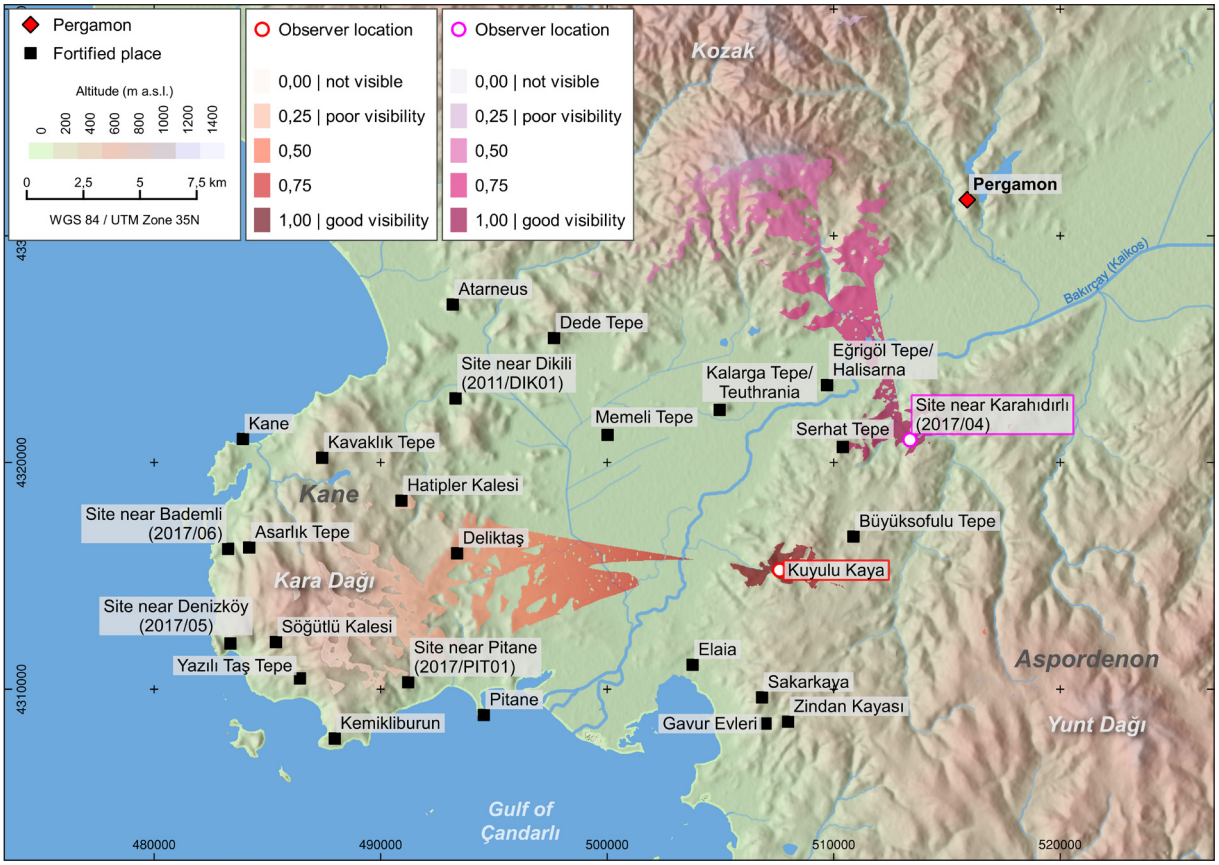

Fig. 5.3.7 Higuchi viewshed from Kuyulu Kaya (red) and the site near Karahıdırlı (2017/04) (violet) (10 m observer height).

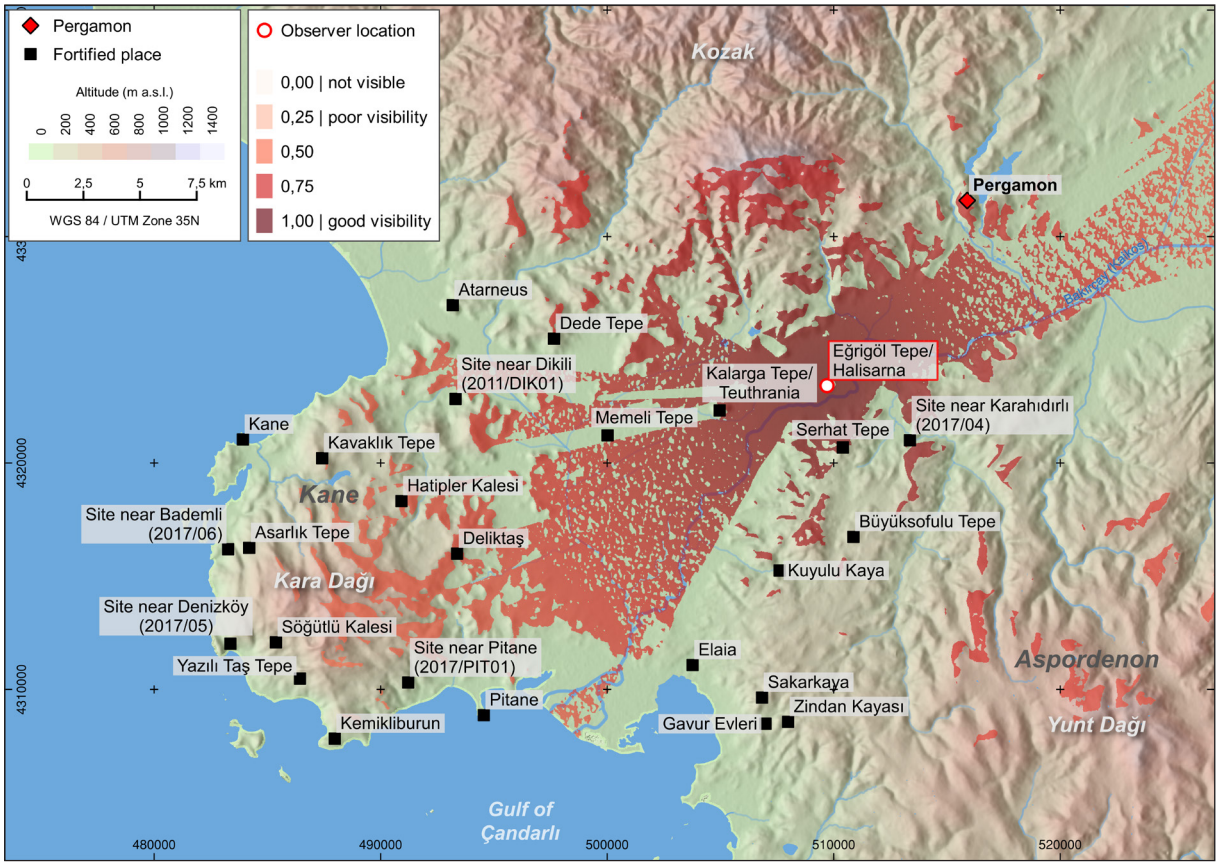

Fig. 5.3.8 Higuchi viewshed from Eğrigöl Tepe/Halisarna (10 m observer height).

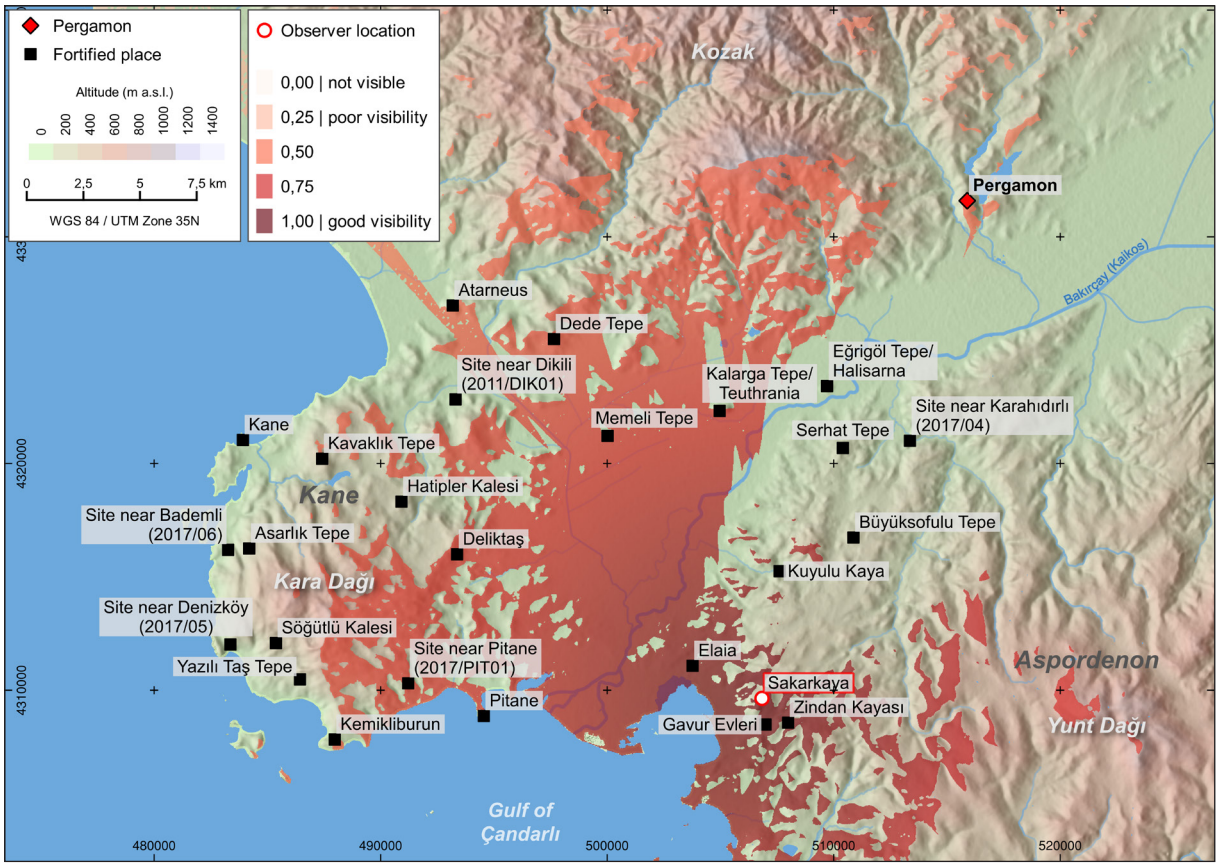

Fig. 5.3.9 Higuchi viewshed from Sakarkaya (10 m observer height).

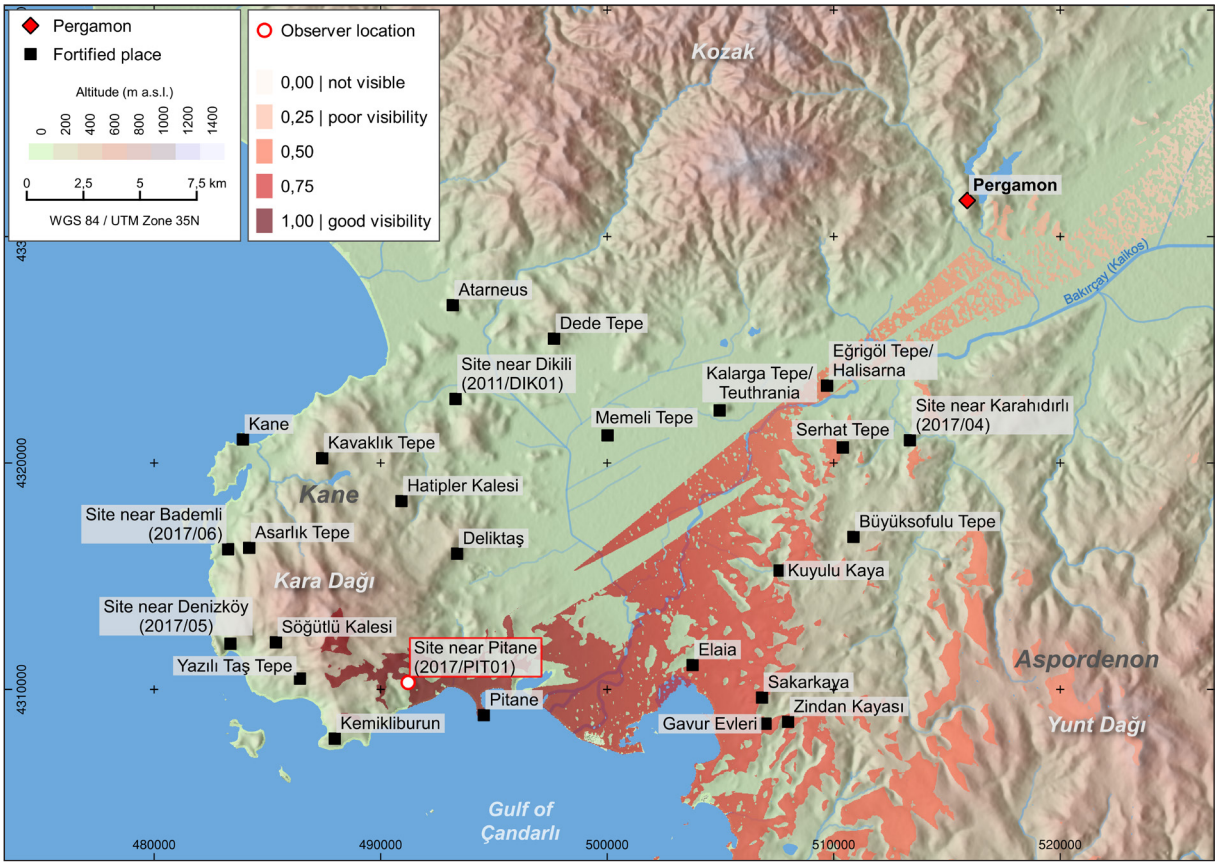

Fig. 5.3.10 Higuchi viewshed from Site near Pitane (2017/PIT01) (10 m observer height).

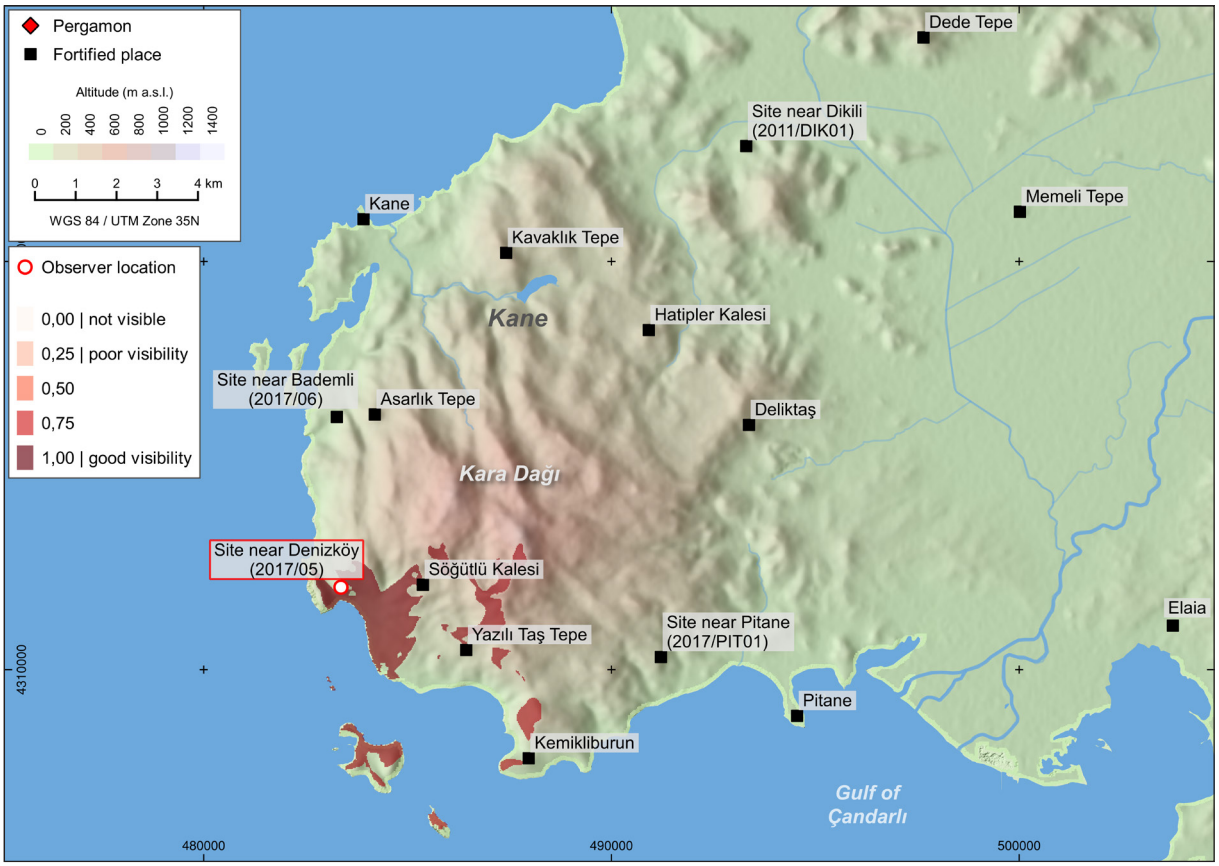

Fig. 5.3.11 Higuchi viewshed from Site near Denizköy (2017/05) (10 m observer height).

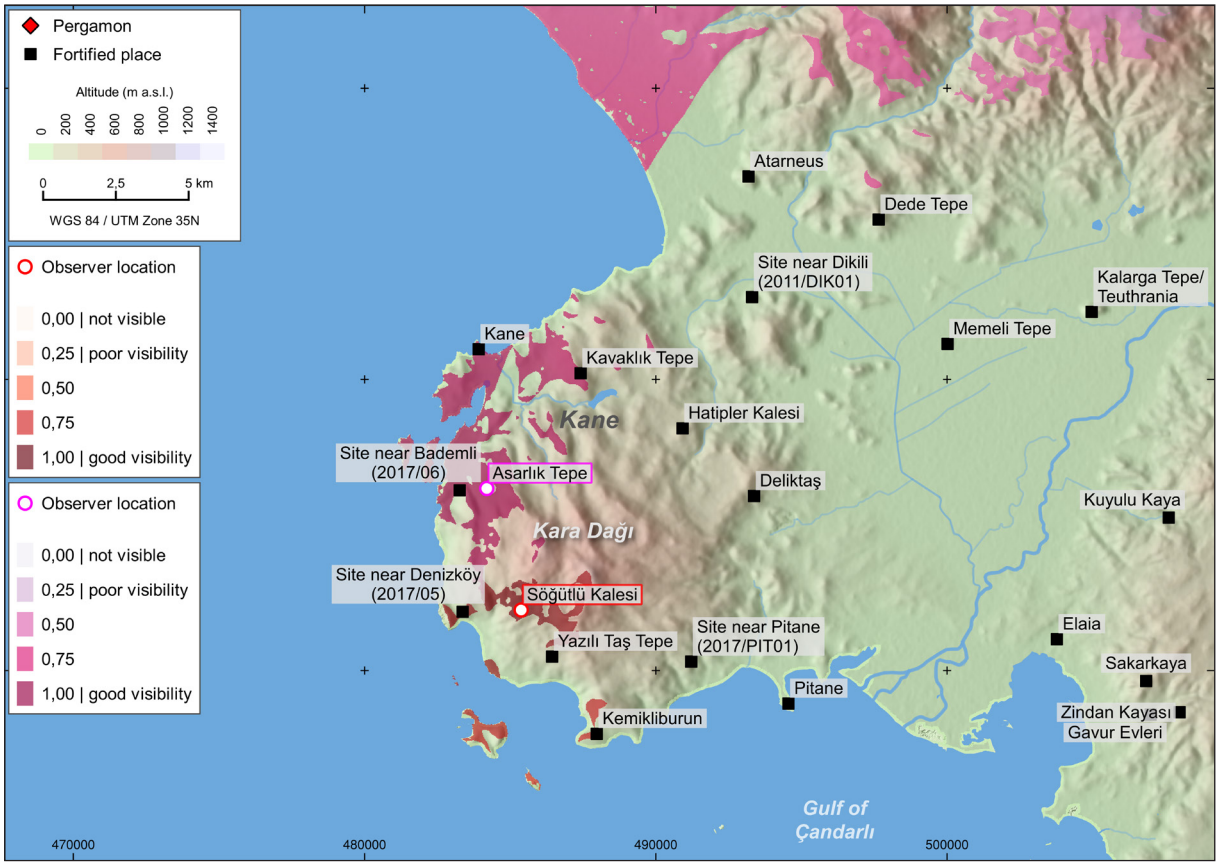

Fig. 5.3.12 Higuchi viewshed from Söğütlü Kalesi (red) and Asarlık Tepe (violet) (10 m observer height).

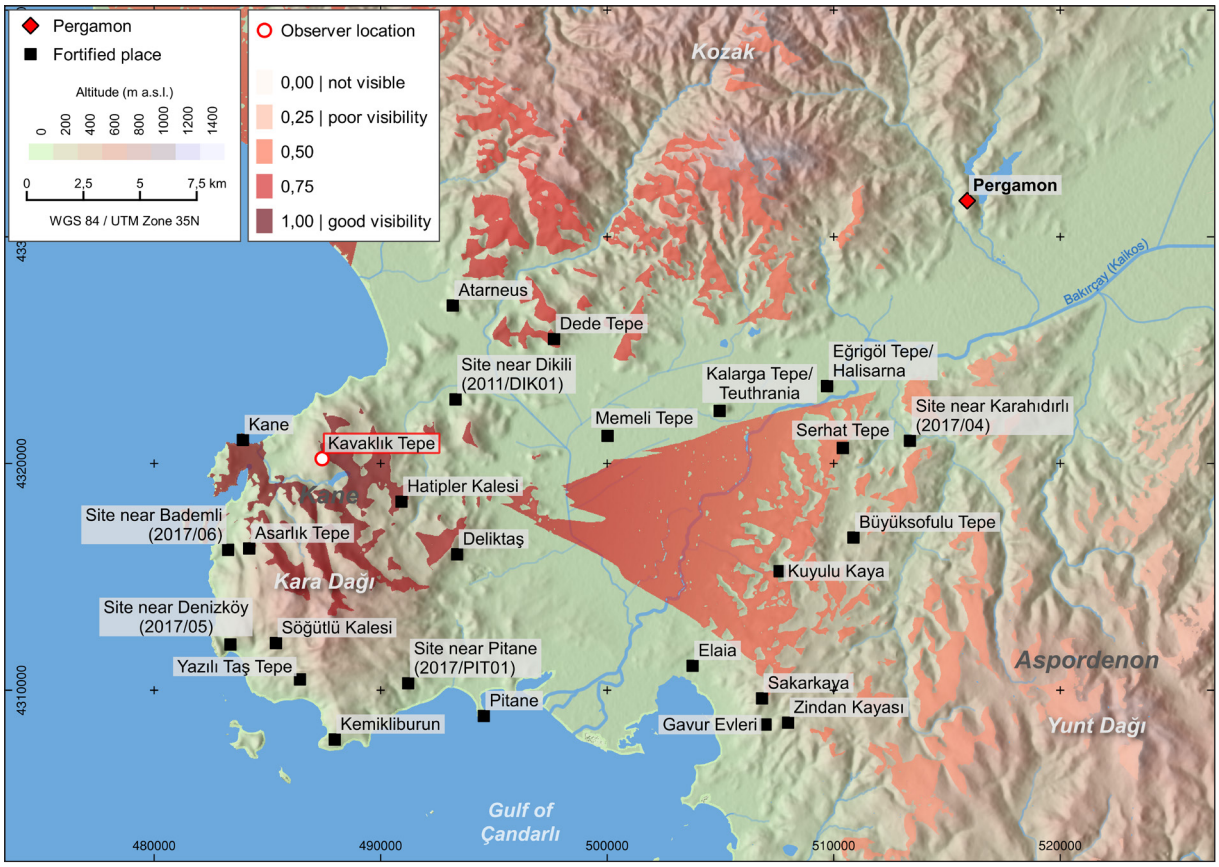

Fig. 5.3.13 Higuchi viewshed from Kavaklık Tepe (10 m observer height).

5.2.2 A Cumulative Viewshed of All Sites

The individual viewsheds were combined into a cumulative viewshed representing the entire area that could be viewed from all sites (Fig. 5.3.14). It is obvious that the western lower Bakırçay Plain and the footslopes of the surrounding mountains are very well covered. However, large valleys in the Kozak and Yunt Dağı Mountains are not visible. In particular, two valleys (Sınır or Değirmen Valley and Gümüşova Valley) a few kilometers south of Pergamon are 'blind spots'. Given the troubled times, it would be highly unusual if one could approach Pergamon 'unseen' so close. Further field research in the area may well reveal more fortifications that could visually cover these areas. Another possibility, which also applies to the Kara Dağı and Kozak Mountains, are temporary camps, the remains of which we have no evidence of today. Based on the results of this study, potential places where targeted fieldwork would be necessary can be narrowed down in the end.

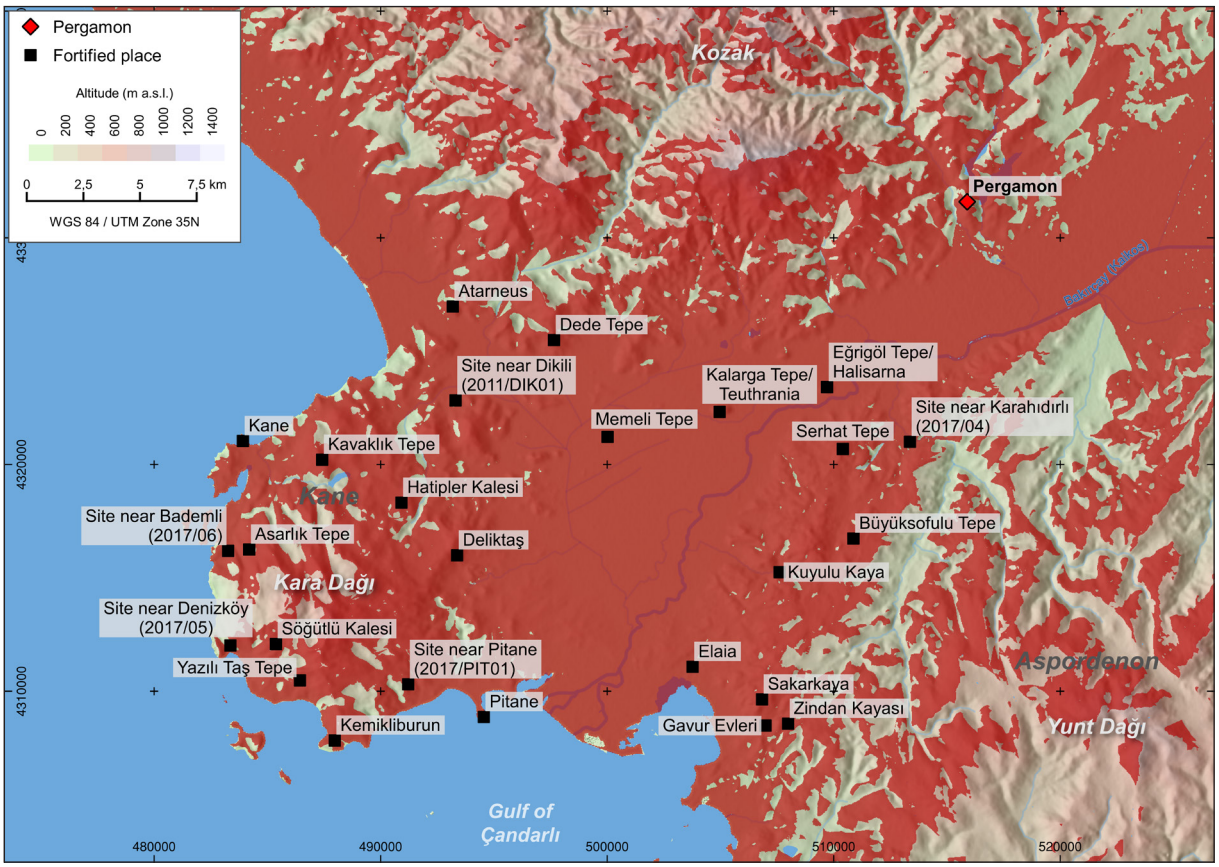

Fig. 5.3.14 Cumulative viewshed from all fortified places.

5.2.3 Line-of-Sight Connections/ Inter-Visibility Network

We assumed 10 m as the theoretical observer height from a potential tower or building at all sites. Figure 5.3.15 shows the individual results of calculated observer heights 5 m, 10 m, 15 m, and a combination of all results. If there is a mutual line of sight between two locations, a line was drawn. There are only minor differences between the calculations with 5 and 15 m observer heights, so 10 m can serve as a good basis for interpretation.

The result is an inter-visibility network extending from Pergamon to the coast and including all sites used in this study. Pergamon had up to eight visual connections to other fortresses and was thus exceptionally well connected.

There are several nodes essential to the network. From their isolated location within the plain, these are of course Eğrigöl Tepe/Halisarna, Memeli Tepe, and Kalarga Tepe/Teuthrania, the latter certainly being key due to the multiplicity of its connections. The same is true for Serhat Tepe and the fortress on Sakarkaya, each of which provides connections in all directions.

The special role of the fortress on Kavaklık Tepe in the Kara Dağı Mountains as a visual hub between Kane, the coastline and the Bakırçay Plain can be confirmed. This fortress creates a visual link between these two completely different landscape units. It also connects Kane and Asarlık Tepe, which in turn can see large parts of the coastline there, among others, with Kalarga Tepe/Teuthrania and thus also with Pergamon. The other two major harbor cities, Pitane and Elaia, are also well integrated into the visual network.

On the southern Kane Peninsula, Kemikliburun has the role of a visual hub. However, there are no direct connections between Kemikliburun and Pitane or the fortress near Pitane (2018/PIT01). In addition, sites connected in the southwest of the Kane Peninsula can be assigned more of a local function, such as the site near Denizköy (2017/05) visually covering only the adjacent bay. If one also dismisses the stronghold function of Söğütlü Kalesi, one can conclude that the southwestern part of the Kane Peninsula, which has no major port city, was part of a defense network only to a limited extent.

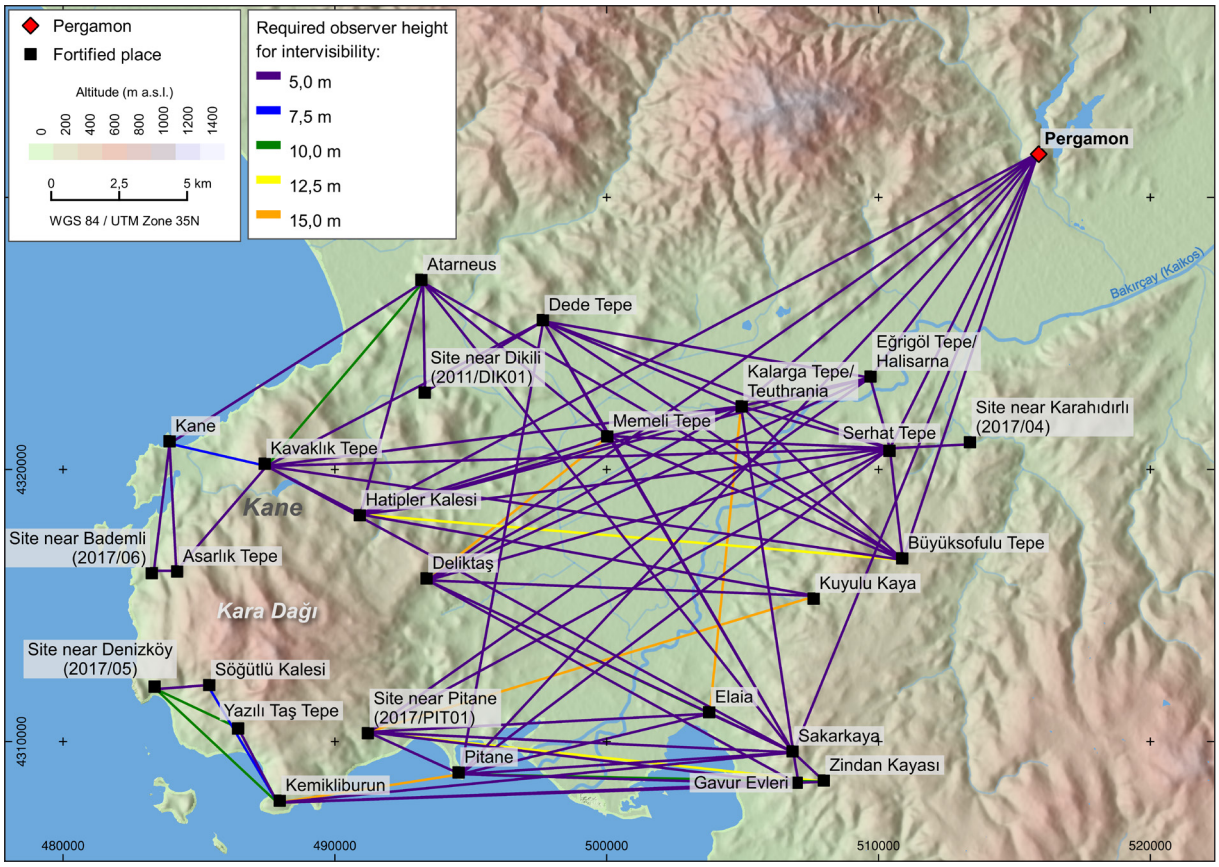

Fig. 5.3.15 Network of inter-visibility between fortified places in the western Pergamon Micro-Region combined from different observer heights: 5 m, 7.5 m, 10 m, 12.5 m, and 15 m.

The results show a dense network of mutual visual connections between all fortified sites in the Hellenistic period. To what extent this existing inter-visibility network was used for communication and surveillance by the Attalid rulers of Pergamon will further be discussed at the end.

5.2.4 Natural Visuality

The mostly exposed location of the studied fortresses not only allowed a view into the landscape. Due to their position, the sites also formed visual reference points for the people living in or moving through the micro-region. Especially in this heterogeneous landscape, the sites may have served as landmarks or places of retreat for the local population. At the same time, they represented regional landmarks that both defined the local landscape while marking Attalid claims of territory and control beyond the confines of the city.

The results of the cumulative viewsheds indicate a tight visual connection among the features seen from land. As mentioned in the beginning, the Kane peninsula, the Kozak Mountains, and the crests of the Yunt Dağı together frame the western lower Bakırçay Plain. The analyses show this as their peaks and foothills are the darkest shade, indicating that they are viewed the most frequently (Figs. 5.3.16, 5.3.18). But the analysis also shows a consistency of visibility in the Bakırçay Plain itself, with the fortifications generally on naturally prominent features. This internal coherence actually increases further inland, becoming darker in the upper Bakırçay Plain, and east of Pergamon. Moreover, much of the sea is also consistently visible from land, proving that integrated connection especially with the gulfs of Çandarlı and Dikili. Yet from the opposite perspective, the plain of the Bakırçay is virtually hidden from the sea, whereas the western fringes of the Kane peninsula, the Kozak Mountains, and the Yunt Dağı, are prominently in view (Figs. 5.3.17, 5.3.18). In terms of a visual region, we may see two distinctive perspectives. The land view shows a highly integrated coherent region that connects most of the Bakırçay Plain and the surrounding hills with the sea, whereas the sea view largely stops at the coastal heights. These heights therefore serve as pivotal ‘hinges’ that can connect the view over land and sea, thereby potentially extending the sense of territory that would naturally be afforded by the strong visual region of the landscape, whether or not they were crowned with fortifications or other landmarks[661].

661 Williamson 2016.

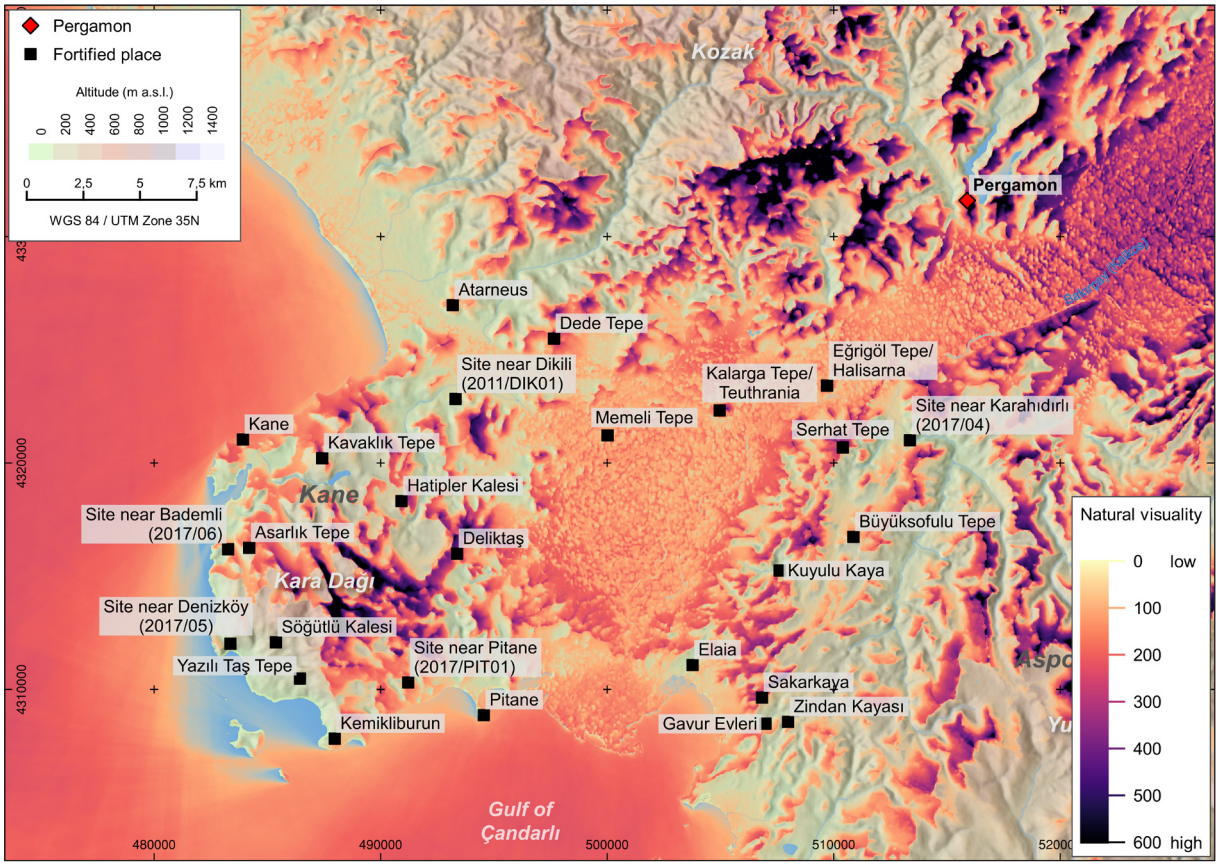

Fig. 5.3.16 Natural visuality of the western micro-region from land perspective.

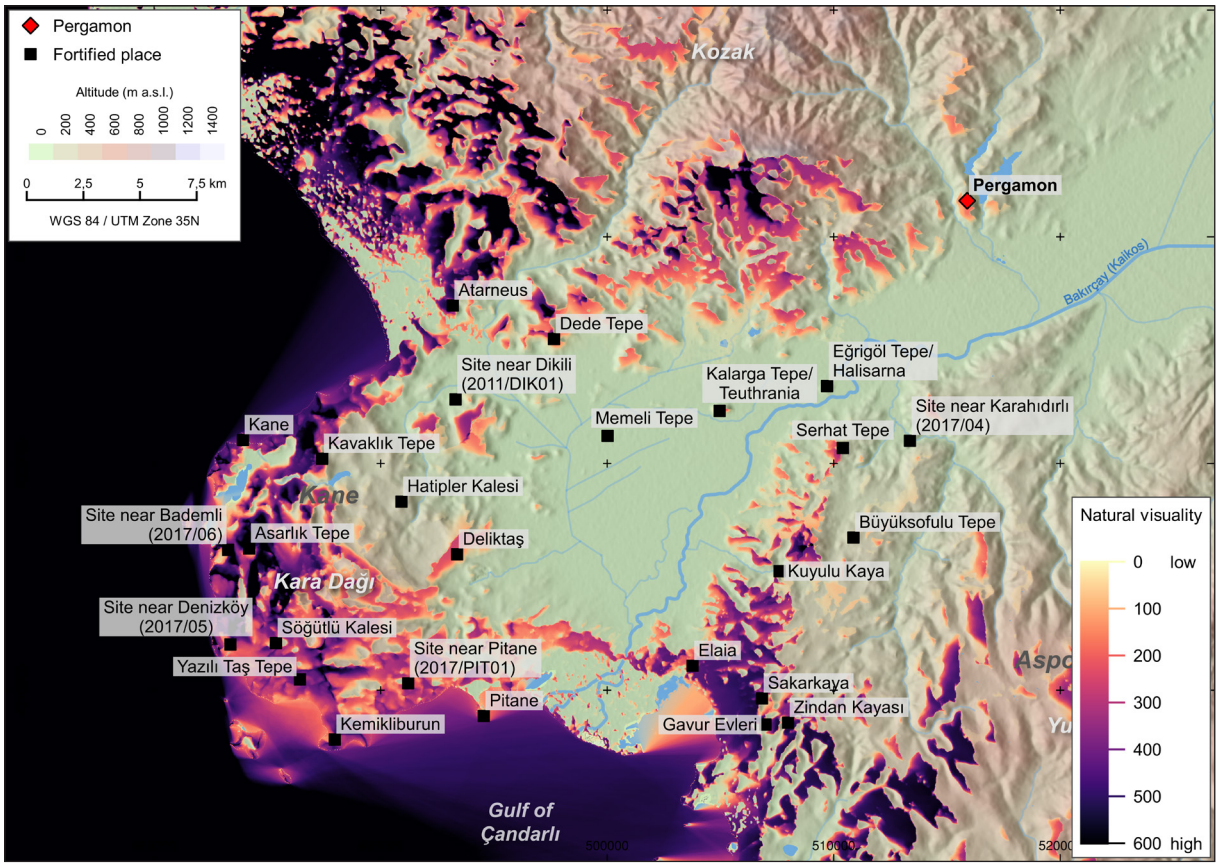

Fig. 5.3.17 Natural visuality of the western micro-region from sea perspective.

Land view			Sea view		
Place name	**hit count**	**%**	**Place name**	**hit count**	**%**
Pergamon	711.9	7.1	Atarneus	524.3	26.2
Serhat Tepe	496.8	5.0	Sakarkaya	504.8	25.2
Sakarkaya	404.8	4.0	Asarlık Tepe	501.4	25.1
Eğrigöl Tepe/Halisarna	395.0	4.0	Dede Tepe	468.2	23.4
Dede Tepe	381.3	3.8	Yazılı Taş Tepe	421.3	21.1
Kalarga Tepe/Teuthrania	379.6	3.8	Kane	364.0	18.2
Deliktaş	353.8	3.5	Site near Denizköy (Site 2017/05)	358.2	17.9
Büyüksofulu Tepe	317.6	3.2	Site near Pitane (Site 2017/PIT01)	304.4	15.2
Hatipler Kalesi	303.1	3.0	Site near Bademli (Site 2017/06)	238.2	11.9
Site near Pitane (Site 2017/PIT01)	227.5	2.3	Söğütlü Kalesi	227.5	11.4
Kavaklık Tepe	197.7	2.0	Kalarga Tepe/Teuthrania	225.3	11.3
Kane	170.0	1.7	Gavur Evleri	223.3	11.2
Memeli Tepe	166.9	1.7	Deliktaş	212.1	10.6
Atarneus	164.5	1.6	Elaia	201.5	10.1
Pitane	156.2	1.6	Serhat Tepe	199.2	10.0
Site near Dikili (Site 2011/DIK01)	110.3	1.1	Pitane	181.7	9.1
Asarlık Tepe	107.9	1.1	Kemikliburun	171.2	8.6
Gavur Evleri	64.7	0.6	Büyüksofulu Tepe	140.9	7.0
Elaia	51.6	0.5	Zindan Kayası	84.2	4.2
Kemikliburun	44.4	0.4	Kavaklık Tepe	54.9	2.7
Kuyulu Kaya	44.2	0.4	Eğrigöl Tepe/Halisarna	46.8	2.3
Site near Karahıdırlı (Site 2017/04)	32.4	0.3	Pergamon	30.2	1.5
Zindan Kayası	16.2	0.2	Memeli Tepe	8.6	0.4
Yazılı Taş Tepe	8.0	0.1	Site near Dikili (Site 2011/DIK01)	4.1	0.2
Söğütlü Kalesi	4.5	0.0	Hatipler Kalesi	1.2	0.1
Site near Denizköy (Site 2017/05)	3.4	0.0	Kuyulu Kaya	0.0	0.0
Site near Bademli (Site 2017/06)	1.8	0.0	Site near Karahıdırlı (Site 2017/04)	0.0	0.0

Fig. 5.3.18 Sites and their degree of natural visuality expressed in hit counts sorted in descending order. Average hit count land view: 196.9 = 2% of all sample points (9,999) and sea view: 211 = 10% of all sample points (2,000).

5.3 Isochrones

A prominent position within the landscape increases the possibilities for monitoring the surroundings and for communication. At the same time, however, it must be possible to reach the monitored area in as short a time as possible. We therefore examined the potential radius of activity or movement around the fortifications. The isochrones indicate the area that can be reached in a given time. We assume a pedestrian with a speed of 5 km/h and so each isochrone marks one hour of walking.

From Pergamon one could reach Eğrigöl Tepe/Halisarna in less than 3 hours and Elaia in about 6 hours (Fig. 5.3.19). But a fortress also has a great influence on its immediate surroundings. Who or what in the vicinity was of importance or worth protecting? Which routes, resources, settlements, borders or other fortresses are in near walking distance?

The one-hour isochrone of Eğrigöl Tepe/Halisarna, a steep and very prominent hill in the plain, covers the narrowest part of the western lower Bakırçay Plain (Fig. 5.3.20). The main road to the coast and to Elaia was vital for the city and ran through this area[662]. The crucial bridges over the river were also located in this same area, which underlines the importance of this fortress as an important outpost of Pergamon[663].

C. Schuchhardt[664] mentions more than a dozen Hellenistic watchtowers that form a belt around the harbor city of Pitane at the beginning of the 20th century. The fortress west of Pitane (2017/PIT01), one hour away, was probably part of this local fortification system (Fig. 5.3.20). Further remains of this fortification are lost today or remain undiscovered, but future fieldwork may focus on the area of the one-hour isochrone. The same phenomenon can even be observed for the harbor of Elaia, whose protection by the fortress on Sakarkaya has been previously outlined. These two places are also within an hour's walk of each other (Fig. 5.3.20).

The combination of the one-hour isochrones shows that from almost all fortresses one could reach the respective neighboring fortress in about one hour on foot (Fig. 5.3.21). Riding a horse, one would even be faster still[665]. Due to the positioning of the fortresses, it was not only possible to communicate with each other and with Pergamon, but also to reach almost the entire western lower Bakırçay Plain in a relatively short time. Only the gap in the immediate vicinity of Pergamon raises the question whether there are other, so far undiscovered, fortresses there. Perhaps, however, this was intentional, so that especially in the immediate vicinity of the city no fortresses were available that could be controlled by attackers in a siege of the city.

662 Ludwig 2020.

663 Pirson 2012a.

664 Schuchhardt 1887.

665 Busby – Rutland 2019, 119.

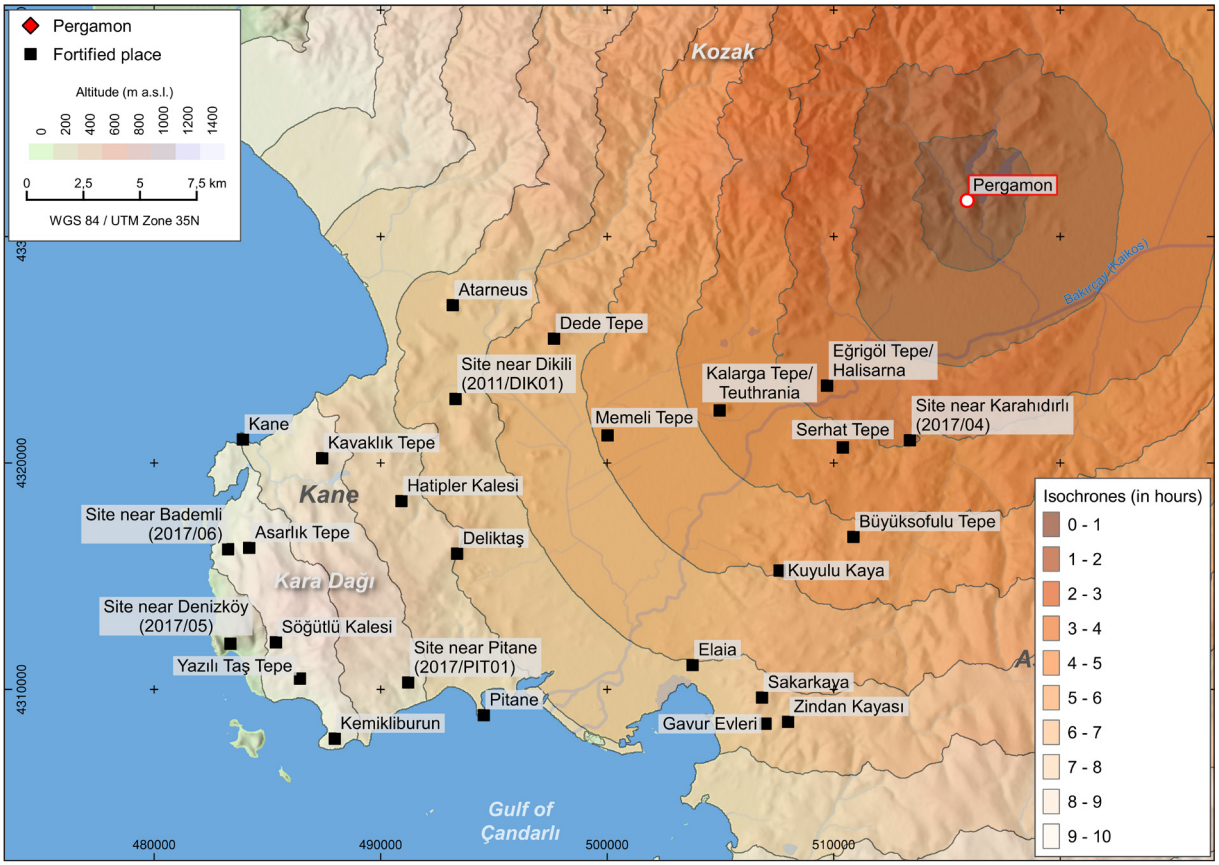

Fig. 5.3.19 10-hour isochrones from Pergamon.

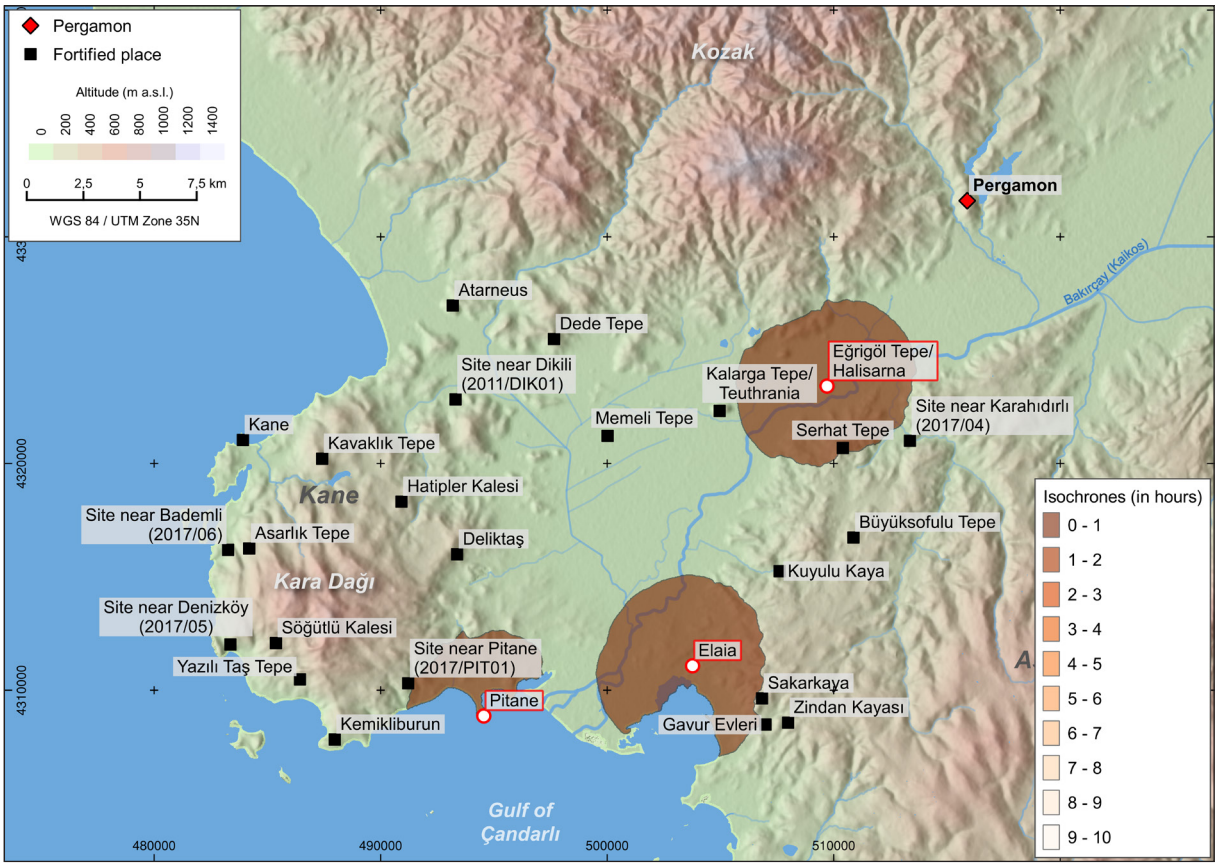

Fig. 5.3.20 1-hour isochrones from Eğrigöl Tepe/ Halisarna, Pitane, and Elaia.

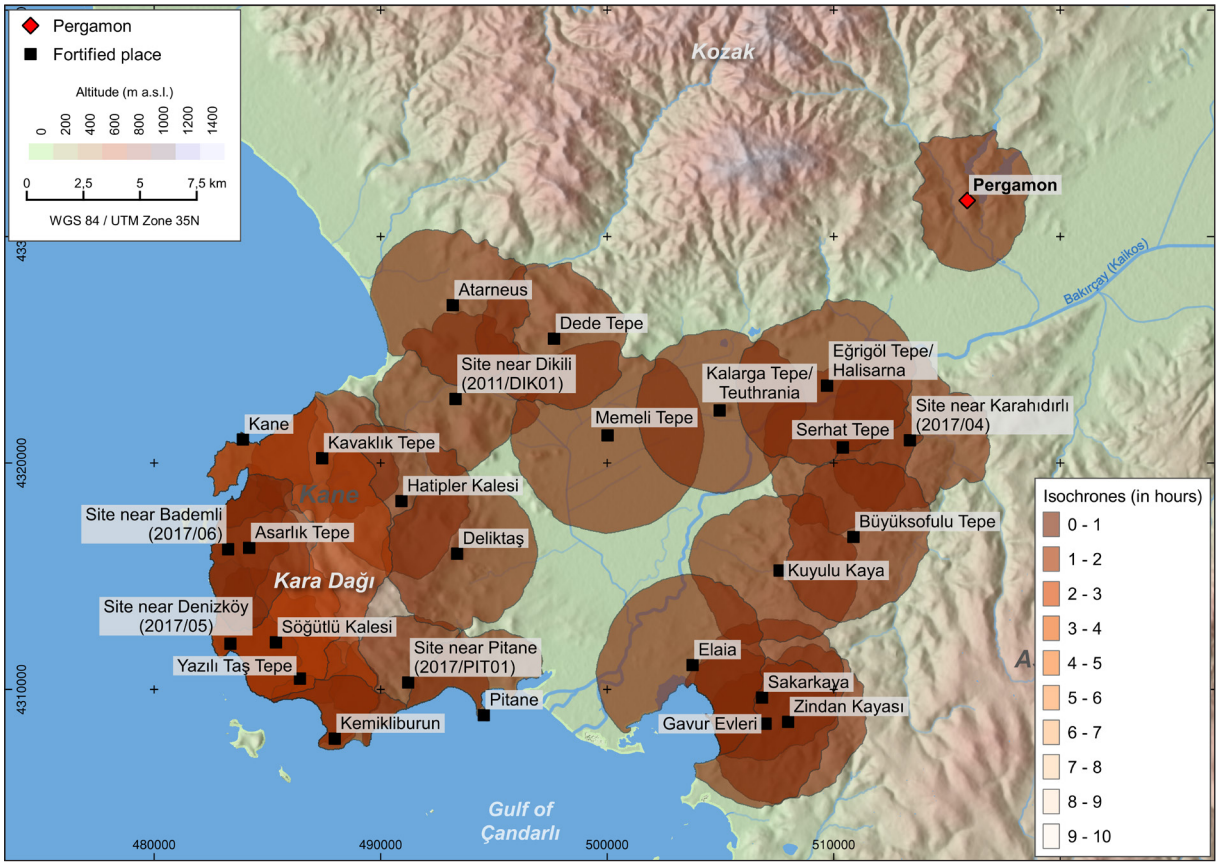

Fig. 5.3.21 Combined 1-hour isochrones of all sites.

5. Discussion

The aim of the study was to investigate whether and to what extent the Hellenistic rulers of Pergamon were able to monitor and control their core territory from the acropolis on the northern edge of the Bakırçay Plain. This study therefore focused on fortified places being of central importance for the surveillance of this region. Following a landscape approach and based on a digital elevation model, we carried out analyses focusing on the aspects of visibility, relative topographic site location and the modeling of movement. These analyses also enabled us to assess the potential of the fortified places forming a communication network with Pergamon as part of a state-run defense strategy.

For access to the resources of the micro-region and for military protection of the city and its supply routes, the establishment and control of the immediate territory of the city would have been of utmost importance to the Attalid rulers. The boundaries of the Pergamene *chora* however are only known in very fuzzy outlines[666]. The term boundary does not mean a defined state (border) line in this context, but how ancient inhabitants may have perceived the territorial claim of Attalid power in the landscape[667]. According to F. Pirson, C. G. Williamson and U. Wulf the perception of Attalid presence in the landscape was represented by rural sanctuaries at Kapıkaya in the Kozak Mountains and Mamurt Kale in the Yunt Dağı Mountains and expressed through their visual connections to the city[668]. This notion can now be

666 Sommerey 2008.

667 Sommerey 2012.

668 Wulf 1999, 33–49; Pirson 2008a, 36–37; Williamson 2014a.

enhanced by the analyses of fortified places, which were also positioned at prominent points within the micro-region and linked through visual connections. They were also visible from many areas of the landscape expressing Attalid power.

The results of the calculation of natural visuality show that the mountains surrounding the Bakırçay Plain lead to the perception of a closed and bounded landscape (Fig. 5.3.16). The western lower Bakırçay Plain, the foothills of the adjacent mountains and parts of the Kane Peninsula have a high natural visuality. An impression of enclosure is simultaneously evident from the coastal perspective (Fig. 5.3.17). This region, bounded by physical barriers, has also been described as a 'visual region' by C. G. Williamson[669] in the context of Kalarga Tepe/Teuthrania serving as a visual hub (Figs. 5.3.5, 5.3.15). Center of power and communication in the region however was Pergamon, whose strategic location is illustrated by its outstanding natural visuality (Fig. 5.3.18) and commanding view (Figs. 5.3.2, 5.3.4). Thanks to these topographical conditions and the additional placement and use of the fortified places in the vicinity, the described region could be monitored and controlled from the acropolis. Following a spatial strategy, visual relationships were thus created between Pergamon and these specific spots in the landscape stating the claim of territorial power and simultaneously enabling intra-territorial interaction and communication (Fig. 5.3.15). Approaching enemies, armies, mobile tribes, and even natural threats such as forest fires could be spotted across the entire region (Fig. 5.3.14). Information could then be rapidly transmitted from Pergamon to the region and vice versa (Fig. 5.3.15). Considering the dynamic political and military conflicts in the turbulent Hellenistic period, a working communication network offered great advantages. Since we were able to prove the existence of such a network, we can assume that the Attalids used these places as parts of their surveillance system in the context of a state-run defense strategy.

Some places, such as Eğrigöl Tepe/Halisarna or Büyüksofulu Tepe for example, already existed in the archaic period and continued to be used in Hellenistic times. Many others, such as Atarneus, Kalarga Tepe/Teuthrania, Hatipler Kalesi and several fortified places along the coastline, however, did not survive the transformative Hellenistic period and the integration of the Attalid kingdom into the Roman state. Some sites seem to be razed in the aftermath of warlike conflicts[670], while others may have become obsolete due to the changing political conditions in the Roman Imperial period. In any case, a transformation of geopolitical power across the Pergamon Micro-Region is evident. Localized power slowly diminished and a network of state (sponsored) defenses began to appear under Attalid rule. This system enabled surveillance and control of their existential core territory and set a stable foundation for the development and success of the city of Pergamon. In the Roman Imperial period, changing political conditions finally led to the abandonment of many fortified places and thus to the end of the surveillance network.

For the supply of the city, permanent access to resources, such as timber, firewood or fresh water, as well as their exploitation and transport to Pergamon had to be ensured. Especially the fertile plain of the Bakırçay, whose agricultural resources ensured the basic food supply of the city was of primary importance[671]. The arable land and its farmsteads could be monitored and controlled by fortifications

669 Williamson 2014a; Williamson 2016.

670 Pirson 2017, 92–95.

671 Pirson – Zimmermann 2014; Laabs – Knitter 2021.

on Kalarga Tepe/Teuthrania or Eğrigöl Tepe/Halisarna in the plain (Figs. 5.3.5, 5.3.8, 5.3.15) as well as fortified places located on the slope facing the plain, such as Serhat Tepe or even Pergamon itself (Figs. 5.3.4, 5.3.6, 5.3.15). Apart from being visible from afar, garrisons were able to reach large parts of the plain in a very short time (Fig. 5.3.21). The fortress on Serhat Tepe and Büyüksofulu Tepe visually dominating a mountainous region of the Yunt Dağı could have encouraged people to settle also in this fertile intramontane basin (Fig. 5.3.6). Small and narrow side valleys, such as the Tekkedere Valley northeast of Elaia, were also settled and used for agriculture in Hellenistic times. The Kuyulu Kaya was a central place of this small valley. From its elevated position, the entire valley could be monitored (Fig. 5.3.7) and the fortress also served as a retreat for the local community.

A more differentiated situation is evident for the Kane Peninsula. The harbors and other fortified places along the entire coastline had close (visual) relations to the sea, to individual bays and landing sites which were already addressed in other contexts[672]. Their close connection to the sea is additionally evident from their natural visuality calculated from the sea perspective (Figs. 5.3.17, 5.3.18).

On the contrary, the towers of Söğütlü Kalesi and Asarlık Tepe, whose function has not yet been clearly identified, are situated away from the coastline in the Kara Dağı Mountains. They have been interpreted as *Turmgehöfte*, i.e., towers as part of a private agricultural estate[673]. However, a primarily military function of the towers cannot be excluded either. At present, there is no regional and differentiating settlement typology that would allow distinguishing fortified towers and *Turmgehöfte*[674], but some more precise and differentiated suggestions for interpreting them can now be made, based on our results: Both Söğütlü Kalesi and Asarlık Tepe, and even Kavaklık Tepe further north, are surrounded by plateaus and agricultural terraces. However, their topographical location and visibility characteristics differ greatly. Söğütlü Kalesi has a very low TPI value and is situated on the slopes of the Kara Dağı Mountains (Fig. 5.3.3). The view from this place is largely limited to the surrounding hillsides (Fig. 5.3.12). Direct lines of sight to the fortresses near Denizköy (2017/05) and Yazılı Taş Tepe exist (Fig. 5.3.15), but features characterizing a fortification, i.e., an exposed position or a commanding view, are missing. It is most likely that the tower at Söğütlü Kalesi was a private *Turmgehöft*, being part of an agricultural estate, serving residential or storage purposes and as a place of retreat for the local community in case of emergency.

Asarlık Tepe, on the other hand, is located on a ridge and has relatively high TPI values compared to the other fortifications (Fig. 5.3.3). Furthermore, the calculated viewshed is not limited to the immediate surroundings, but includes a large coastal strip with the Arginusae Islands, Kane and the fortress on Kavaklık Tepe (Fig. 5.3.12). A clear functional assignment is not possible, but both an agricultural and a military function seem possible. The visual and topographical characteristics, as well as the easy accessibility of the harbor of Kane in a little more than an hour and via a documented ancient road section[675], can be interpreted in both ways. The tower of Asarlık Tepe is representative for the difficulties of functional classification of such places and reveals the wide range of factors and decisions related to the choice of a location. A tower originally built as part of a private farmstead may have been used as a

672 Laufer 2020; Ludwig 2022.

673 Zimmermann et al. 2015, 213.

674 Schuler 1998, 83–90.

675 Pirson 2016, 184–185 (E. Laufer); Ludwig 2020, 27–28.

state military base during the changing and uncertain political times in the Hellenistic period. Even a simultaneous use for agricultural and military purposes does not seem to be excluded here and more research is needed.

Kavaklık Tepe has been interpreted as a fortress since its discovery at the end of the 19th century. In fact, geomorphological calculations show that the site is not as exposed as assumed (Fig. 5.3.3). Plateaus and terraces in the immediate vicinity of the place could have been used for agriculture. Its viewshed, however, illustrates the favorable strategic position that allows a wide view ranging from the coast to the Bakırçay Plain (Fig. 5.3.13). At least eight direct lines of sight to other sites make the fortress a visual hub that provided (visual) communication across the rough and mountainous northern Kane Peninsula (Fig. 5.3.15). The fortress probably also served as an observation point for the security of the route leading from Kane into the Bakırçay Plain[676]. A primary military use can therefore be assumed. This does not however exclude an agricultural function, which may have been practiced to a limited extent on the mentioned plateaus for the supply of the stationed garrison.

These examples show that the differentiation between military and agricultural function must be answered individually for each of the fortified places. A decision is not always possible, but an integrative approach that examines the places in the context of their surrounding landscape allows more profound interpretations.

Kavaklık Tepe is not the only fortress that can be associated with securing routes. The strategic position of Elaia and the fortress on Sakarkaya for securing the coastal road and the southwestern access to the plain has already been discussed in other contexts[677]. A similar situation is evident near Atarneus with the fortified places near Dikili (2011/DIK01) and on the Dede Tepe at the northwestern entry to the plain. But smaller side valleys with roads leading into the core of Pergamene territory were secured by fortresses. One example is the fortress near Karahıdırlı in the Değirmendere Valley, which, due to its topographical and visual characteristics, can only be associated with the control of the route leading through the narrow valley (Figs. 5.3.3, 5.3.7). There is no suitable land for agriculture in the immediate vicinity of the site, making the placement of buildings for storage and residential purposes highly unlikely.

In addition to the fortified places included in this study, scattered settlements in the Pergamon Micro-Region are assumed to have existed during the Hellenistic period[678]. Some names of these settlements have survived from the Pergamene ephebe lists[679], but little is known about their location, size, or density. A promising avenue for further research would be to investigate the relationships of the fortified places in the Pergamon Micro-Region with such local settlements, pending further field surveys.

The presented findings and insights are strongly determined by the employed algorithms and raw data. We use high quality open access data, established and reliable free and open-source software[680], and provide our developed code in order to encourage readers to execute and test our analyses on their

676 Ludwig 2020, 27–28.

677 Ludwig 2020; Pirson 2012a.

678 Sommerey 2008.

679 Sommerey 2008, 152–155.

680 Cf. Fortunato – Galassi 2021.

own[681]. Besides, we aimed at creating robust results by choosing a variety of thresholds[682]. The results for these different thresholds show similar trends, thus proving the dependability of the presented findings. Nevertheless, a thorough analysis of the robustness of the results would need to employ different input data (e.g., another DEM) and alternative algorithms, a task that is beyond the scope of this study.

6. Conclusions

In this study we present a novel combination of quantitative spatial analyses to assess the networking potential of ancient rural fortifications and the ability of an ancient city to control its micro-region. This innovative approach offers the opportunity to integrate different fields of research (e.g., Archaeology, Landscape Archaeology and Geography) and thereby provides new perspectives and opportunities in studying historical phenomena and ancient human-environment interactions. The analyses are based on high quality open-access data and were conducted using established and reliable open-source software. By also making the developed code of the analyses available alongside the study, we make our assumptions and decisions transparent and reproducible, encouraging readers to perform and test the analyses, or further develop them for their own specific research question.

In the scope of our research, this landscape approach, allowed for the first time a comprehensive analysis of all known fortifications in the Pergamon Micro-Region in terms of their function and the city's ability to monitor and control its surrounding landscape.

The results of our study highlight Pergamon's strategic position as a center of power and communication by its outstanding natural visuality and commanding view. Based on these particular capabilities, visual relationships between Pergamon and fortified places in the micro-region were created. These places commanded by the Attalids, served to monitor, control and reach strategically and military important areas (e.g., resources, transport infrastructure, and harbors). Located at prominent spots within the landscape, they also stated the claim of territorial power and simultaneously enabled intra-territorial interaction and communication. Considering the dynamic political and military conflicts in the turbulent Hellenistic period, it is most likely that the Attalids used these places as parts of a surveillance system in the context of a state-run defense strategy. This system was not static, however, but changed over time. Looking at the fortified places and their settlement history in a diachronic perspective reveals a transformation of geopolitical power across the Pergamon Micro-Region. Localized power slowly diminished and a network of state (sponsored) defenses began to appear under Attalid rule, which in turn seems to disappear in the Roman Imperial period.

This study and its landscape approach further illustrate the variety of individual functions, the factors governing the placement of fortified places and the complexity of their distribution. The landscape surrounding Pergamon was shaped by various kinds of fortifications: individual towers with a surrounding wall, towers as parts of rural estates (*Turmgehöfte*) or small settlements or even fortified settlements and harbors. Holding power over these places and using them to monitor and control the

681 See Knitter et al. 2021 for a description and explanation.

682 See employed observer heights in the visibility analyses or the different radii in the geomorphometric analyses.

micro-region enhanced the level of security and was thus essential for the development and stability of the Pergamene kingdom during the Hellenistic period.

Even these results do not have to remain static, however, but can be continuously supplemented and refined in the light of new evidence and discoveries in the future thanks to our open and transparent approach.

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Availability of Data and Material: Any data and material required to reproduce this study is provided in our data repository at Zenodo https://zenodo.org/record/5115942 or https://doi.org/10.5281/zenodo.5115942 (Knitter et al. 2021) or available open access.

Code Availability: The code to reproduce the presented analyses is available here: https://zenodo.org/record/5115942 or https://doi.org/10.5281/zenodo.5115942 (Knitter et al. 2021).

6. Synthesis

This cumulative thesis was written as part of a project investigating the 'Transformation of the Pergamon Micro-Region between the Hellenistic and the Roman Imperial period.'[683] One focus of the project is the interdependencies between the doubling of the urban area of Pergamon and the construction of large representative buildings in the city since the late 1st century CE, referred to as urban transformation, and concurrent changes in the Pergamon Micro-Region.[684] As an essential project component for the study of the rural landscape, the goal of this thesis is therefore to identify and interpret the interdependencies between Pergamon, other urban and rural settlements, and the landscape within the Pergamon Micro-Region from the Hellenistic to the Roman Imperial period. To achieve this goal, a landscape approach was adopted, with an emphasis on digital spatial analysis combined with archaeological, geographical, and historical information. Surveys were also conducted to expand the archaeological data base and to verify the analysis results and interpretations, thereby increasing the reliability of the three case studies. In addition, the category of micro-regions serves as a spatial and conceptual framework for this thesis.[685]

By synthesizing the case studies, this thesis also aims to evaluate and reassess the transformation of the settlement structure in the Pergamon Micro-Region over a period of six centuries (3rd century BCE – 3rd century CE). While the concept of transformation is clearly defined in some scientific disciplines (e.g., soil science), it is interpreted extremely differently in other disciplines and overlaps, for example, with the term transition.[686] In general, the term transformation describes the reshaping or transition of a form or pattern from one state to another, and in the following, transformation will be understood as a fundamental change that, from a social perspective, is accompanied by erratic changes in political and economic development. It is a long-term process that, in extra-urban areas, involves a fundamental change in settlement structure and, from a landscape perspective, also affects the dynamic interaction patterns between humans and the natural environment in the past.[687] A transformation is not complete until new structures have become established and stabilized over a longer period of time.[688]

While political and social change between the Hellenistic and the Roman Imperial period has already been studied from a historical perspective[689] and a fundamental change in the urban aspects of Pergamon has most recently been described from an archaeological perspective,[690] in the following synthesis this thesis focuses on the transformation of the settlement structure in the Pergamon Micro-Region from a landscape archaeological perspective.

The synthesis builds on the results of three case studies (chapter 5), each of which examined specific aspects of the Pergamon Micro-Region in detail. It furthermore refers to the two maps of the western Pergamon Micro-Region in the Hellenistic and the Roman Imperial period (Figs. 6.1, 6.3 in chapters

683 See note 3.

684 Pirson 2020, 156–159; TransPergMikro 2022.

685 For a detailed account of the category of micro-regions, see chapter 2.2.

686 Feola 2015.

687 Kluge – Hummel 2006.

688 Deutsches Institut für Urbanistik 2017.

689 Mileta 2008; Marek – Frei 2017.

690 Pirson 2017.

6.1.1 and 6.1.3). They are a product of this thesis and are composed of the results of the case studies and the surveys conducted. The maps serve both to illustrate the conclusions drawn below and to provide a valuable research base for future investigations.

6.1 Conclusions Based on the Case Study Results in a Chronological Overview

6.1.1 Hellenistic Period (3rd – 2nd Century BCE)

During the Attalid reign, the city of Pergamon grew from the 3rd and 2nd centuries BCE. The urban area was considerably expanded and large representative buildings were erected, the remains of which we can admire today.[691] To drive this development and ensure the prosperity of its inhabitants, the city relied on its micro-region. Hardly any other element stands so symbolically for this close relationship between Pergamon and its micro-region as the ancient route network. Routes provided the economic infrastructure and support system for settlements and society, shaping landscapes over long periods of time and providing orientation within them. Despite the paucity of archaeologically known ancient roads or other infrastructure elements in the vicinity of Pergamon, the study in chapter 5.1 has succeeded in reconstructing the ancient route network in the Pergamon Micro-Region for the first time by combining historical and archaeological sources with digital spatial analyses, taking into account the changes that have occurred in the landscape since antiquity.

The results show a micro-region in which rural and urban settlements as well as harbors and their hinterland were connected to each other and to Pergamon by roads as early as Hellenistic times (Fig. 6.1). These could be used for travel and communication, but also for transportation purposes, and overcame landscape barriers such as rivers or mountains. Raw materials from the Kozak Mountains (e.g., wood, granite, or marble), andesite from the quarries on Uzun Bayır and Taş Tepe about 4.5 km northeast of the city hill, and agricultural goods from the fertile Bakırçay Plain could be transported to Pergamon via main transport axes, for example. The reconstructed route network thus provides a novel basis for the study of commercial routes, transportation costs, the settlement structure as well as food and resource flows in the Pergamon Micro-Region.

The Pergamon Micro-Region is i.a. characterized by the Aegean coast in the west. Given the maritime activities in antiquity, the coast with its harbors and landing sites was certainly not a frontier but rather an important node of interaction processes. During the 4th century BCE, several independent *poleis*, including Atarneus, Kane, and Pitane, had developed along the coast and continued to exist under Attalid rule. However, the first *polis* to experience the effects of the increasing power of the Attalid rulers was the harbor town of Elaia, which was developed into the main civil and military port of Pergamon probably as early as the mid-3rd century BCE, under Eumenes I.[692] Reasons generally given in favor of Elaia and against other harbor towns such as Pitane or Kane are its proximity to Pergamon, its connection to the ancient coastal road, or its scenic location at a narrow point between the northwestern Yunt Dağı Mountains and the Gulf of Çandarlı at the southwestern entrance to the Bakırçay Plain.[693] However, a sound evidence basis for such assumptions can only be established through a comprehensive and comparative study of all harbors and landing sites along the coast of the Pergamon Micro-Region. Therefore, based on GIS-assisted and landscape-based analyses, all harbors and landing sites along the maritime facade of the

691 Pirson 2017.

692 Pirson et al. 2015, 24; Feuser et al. 2020, 207.

693 Pirson 2008a; Pirson 2014.

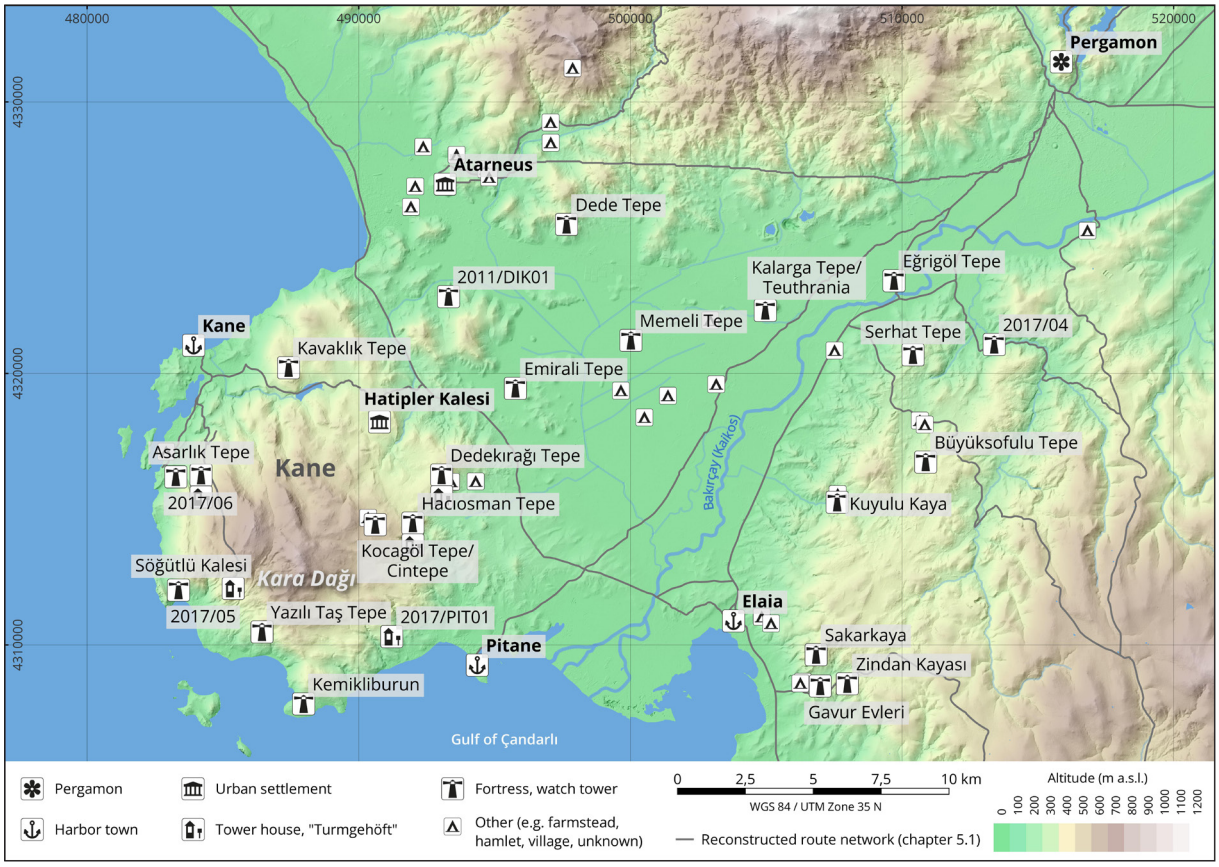

Fig. 6.1 The western Pergamon Micro-Region in the Hellenistic period.

micro-region were examined for the first time in terms of their locational characteristics, functional diversity, structural hierarchy, and relationship to Pergamon and the micro-region.

The results confirm the significant distance advantage of the route between Elaia and Pergamon compared with other harbor locations. The calculated distance to Elaia (27.15 km) was about 18% shorter than to a potential harbor at Atarneus (32.92 km), about 24% shorter than to Pitane (35.57 km), and even about 35% shorter than to Kane (41.76 km). A very similar result was obtained from the reconstruction of the route network.[694] Considering the fact that land transportation in antiquity was much more expensive and time-consuming than transportation by ship, this fact was of great economic importance. Due to its routing through the relatively flat plain, Elaia also offered the shortest travel time between Pergamon and the coast.[695] It was particularly important from a political and military point of view to ensure rapid communication and information transfer to the coast, where the Pergamenian fleet was deployed.

For securing and controlling the harbor and the coastal road, the fortress on Sakarkaya, 3.3 km southeast of Elaia, also played a crucial role. Although it has been referred to in the past as a landmark or observation post[696], it is only the visibility analyses that have revealed its actual key position in the Hellenistic period. While Elaia itself is visually very remote, the visual range and thus the visual control area of Sakarkaya encompasses not only the western Bakırçay Plain but also Elaia, its bay, and the offshore Aegean Sea

694 See Table 5.1.4.

695 See Table 5.2.1.

696 Pirson 2012a, 226; Pirson et al. 2015, 35. See also chapters 5.2 and 5.3.

(Figs. 5.2.4, 5.2.5). At the same time, the fortress could be seen from numerous locations both in the Bakırçay Plain and on the Kane Peninsula or the Gulf of Çandarlı. The results show that the site formed an important landmark for approaching or passing ships (Fig. 5.2.4). Visibility studies were also able to show that the fortress at Sakarkaya most likely had direct lines of sight to Elaia and to the urban settlements of Pitane, Hatipler Kalesi, and Atarneus (Fig. 5.3.15). However, a direct line of sight to and from Pergamon is crucial. Considering the limited possibilities for rapid information transmission in Hellenistic times, the Sakarkaya fortress provided a line of sight between Pergamon and its main harbor, through which, for example, light or smoke signals could be used to transmit at least basic information very quickly. Against this background, the visually remote location of Elaia combined with the high visual potential of Sakarkaya proved to be an extremely advantageous combination and, from an Attalid point of view, extremely attractive for the establishment of a military and economic hub on the coast.

Differences in the relationships between the harbors and Pergamon could also be identified: While Kane may have had at least military value for Pergamon in the Hellenistic period due to its location in a strategically important maritime area, Pitane did not gain importance for Pergamon until the Roman Imperial period, when it offered long-term locational advantages over Elaia.

Furthermore, it could be demonstrated that military surveillance and control aspects were of great importance along the maritime facade of the micro-region in the Hellenistic period. In the vicinity of all harbors or landing sites, watchtowers or fortresses were identified that were purposefully positioned to provide visual surveillance and control of the surrounding area (Figs. 5.3.1, 6.1). Thus, C. Schuchhardt's descriptions of a surveillance system of watchtowers around Pitane could be partially confirmed.[697]

In addition to the coast, however, the interior of the Pergamon Micro-Region was particularly characterized by fortified sites (Figs. 5.3.1, 6.1) because security and military defense capability during the politically turbulent years of Attalid rule, as well as constant access to settlements, harbors, transportation and communication routes, and resources within the micro-region, were the cornerstones for the development and success of Attalid Pergamon. Chapter 5.3 therefore applied a landscape approach based on a novel combination of quantitative spatial analyses to analyze all known Hellenistic fortifications in the Pergamon Micro-Region in terms of their function and the city's ability to monitor and control the surrounding landscape for the first time. The results highlight Pergamon's strategic position as a center of power and communication through its outstanding natural visibility and commanding view. Based on these special capabilities, visual relationships were established between Pergamon and fortified sites in the micro-region. Located at prominent points in the landscape and dominated by the Attalids, these sites served to monitor and control important areas (e.g., resources, transportation infrastructure, and harbors) and illustrated territorial claims to power. It is very likely that the Attalids used these fortified sites as part of a surveillance system in the context of a state defense strategy.

697 Schuchhardt 1887.

6.1.2 Phase of Political-Administrative Transformation (133 BCE – Beginning of the 1st Century CE)

In 133 BCE, Attalus III, the last Attalid ruler, bequeathed Pergamon to the Roman Empire. This event triggered a long period of political-administrative transformation from the Attalid kingdom to the incorporation of Pergamon into the Roman Empire, the effects of which also affected the Pergamon Micro-Region.[698] Earlier survey projects provided evidence that individual fortified sites were either razed or abandoned during the phase from the end of Attalid rule in 133 BCE to the Roman Imperial period. The end of settlement at these sites was quite plausibly associated with the aftermath of the Aristonicus Revolt (133–129 BCE) and the sanctions imposed by Rome as a result of the First Mithridatic War (89–85 BCE).[699] Indications for a demilitarization of the micro-region have also been observed on the basis of a few fortified sites.[700] Only recent surveys and the comprehensive study of all known fortified sites in the western Pergamon Micro-Region in chapter 5.3, however, clarify the full extent of their abandonment.[701] By synthesizing the case study and survey results, this chapter shows for the first time that the proportion of fortified sites (except harbor towns and urban settlements) in the total number of all known sites drops from 40% in the Hellenistic period to 10% in the Roman Imperial period. Although fortified sites are easier to discover because of their preserved remains and may therefore be statistically overrepresented, their high proportion in the Hellenistic period and their decrease in the Roman Imperial period are significant (Fig. 6.2). Further insights into this phenomenon could also be gained in the future through comparative studies with the micro-regions of other cities in Asia Minor, such as Sagalassos, where the rate of abandonment of fortified sites between the Hellenistic period and the Roman Imperial period was low.[702]

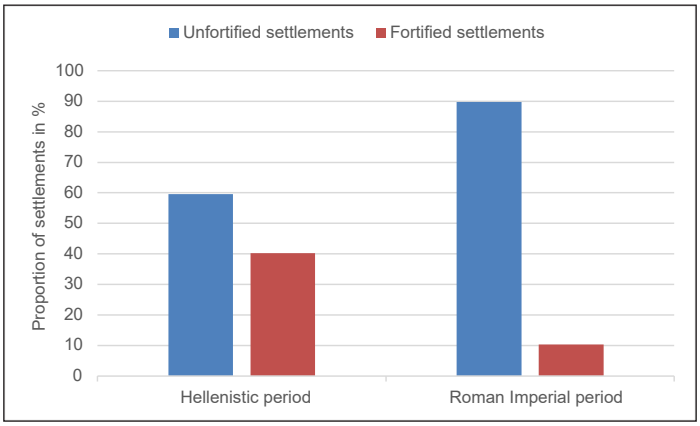

Fig. 6.2 Proportion of unfortified and fortified settlements in the Pergamon Micro-Region in the Hellenistic and Roman Imperial periods. Total number of known sites: 53 (Hellenistic period), 43 (Roman Imperial period).

698 On the Aristonicus Revolt in general, see, e.g., Daubner 2006; Marek – Frei 2017, 324–326, and on the 1st Mithridatic War, see, e.g., Marek – Frei 2017, 345–355.

699 Zimmermann et al. 2015, 213–216; Pirson 2017, 95–96.

700 Zimmermann et al. 2015, 214; Pirson 2017, 112.

701 See chapter 5.3 and appendix.

702 Vanhaverbeke – Waelkens 2003, 241–243 with Graph 8.

In the course of this demilitarization, the aforementioned surveillance system lost its functionality by the Roman Imperial period, and Pergamon lost its micro-regional control and defense capability to some extent. Whether this was a consequence of the aforementioned political-military disputes, whether some places simply lost their military necessity in the course of Pergamon's incorporation into the Roman Empire, or whether it was a complex mixture of such factors cannot be conclusively determined. In any case, parallel to the political-administrative transformation in Pergamon, the beginning of a settlement-structural transformation within the Pergamon Micro-Region could be traced, which would come to a provisional end only in the Roman Imperial period.

6.1.3 Roman Imperial Period (1st – 3rd Century CE)

The Roman Imperial period in Pergamon is less characterized by political-administrative upheavals. It is primarily associated with an enormous urban transformation, namely the doubling of the urban residential area and the construction of numerous large buildings.[703] The results of this thesis show that, in parallel, the mutual relations between Pergamon and its micro-region as well as the rural settlement structure continued to change.

As the route network most likely continued to exist in its basic Hellenistic structure in the Roman Imperial period, we learn many new details that were brought together in chapter 5.1. Milestones and written sources give distances to and from Pergamon for the first time, which were taken into account in the reconstruction of the route network. Inscriptions provide information on repair and expansion work on the main road between Elaia and Pergamon.[704] One of the reasons for the measures could be an intensification of the traffic volume in the course of the urban growth of Pergamon. The construction of a ca. 83 m long bridge over the Bakırçay near Elaia and another presumably Roman bridge south of Eğrigöl Tepe could also be related to this.[705] The great importance of the inner- and outer-city streets in Pergamon is also acknowledged in the Roman Imperial period with the re-erection of an originally Hellenistic inscription on the Lower Agora of Pergamon, the '*Astynomoi* Law.' In this inscription, among other things, the width of the lanes of the country roads (*leophoroi*) within the urban territory is regulated by law.[706]

While the route network most likely changed only minimally, the settlement structure changed all the more. The map for the Roman Imperial micro-region shows a completely changed settlement pattern compared to the Hellenistic period (Fig. 6.3). The fortified sites from the Hellenistic period examined in chapter 5.3 have, as already mentioned, been largely abandoned. At the same time, however, new settlement types are appearing, including thermal baths, villas, and a seaside villa (*villa maritima*) on the island of Elaioussa, and the total number of all known settlements in the micro-region seems to decrease (Fig. 6.3).[707] This development can now be traced much more clearly than before thanks to the case studies and surveys presented here.

703 Pirson 2017.

704 See chapter 5.1.

705 See chapter 5.1.

706 Saba 2012, 27–28.

707 See also Pirson 2017, 113.

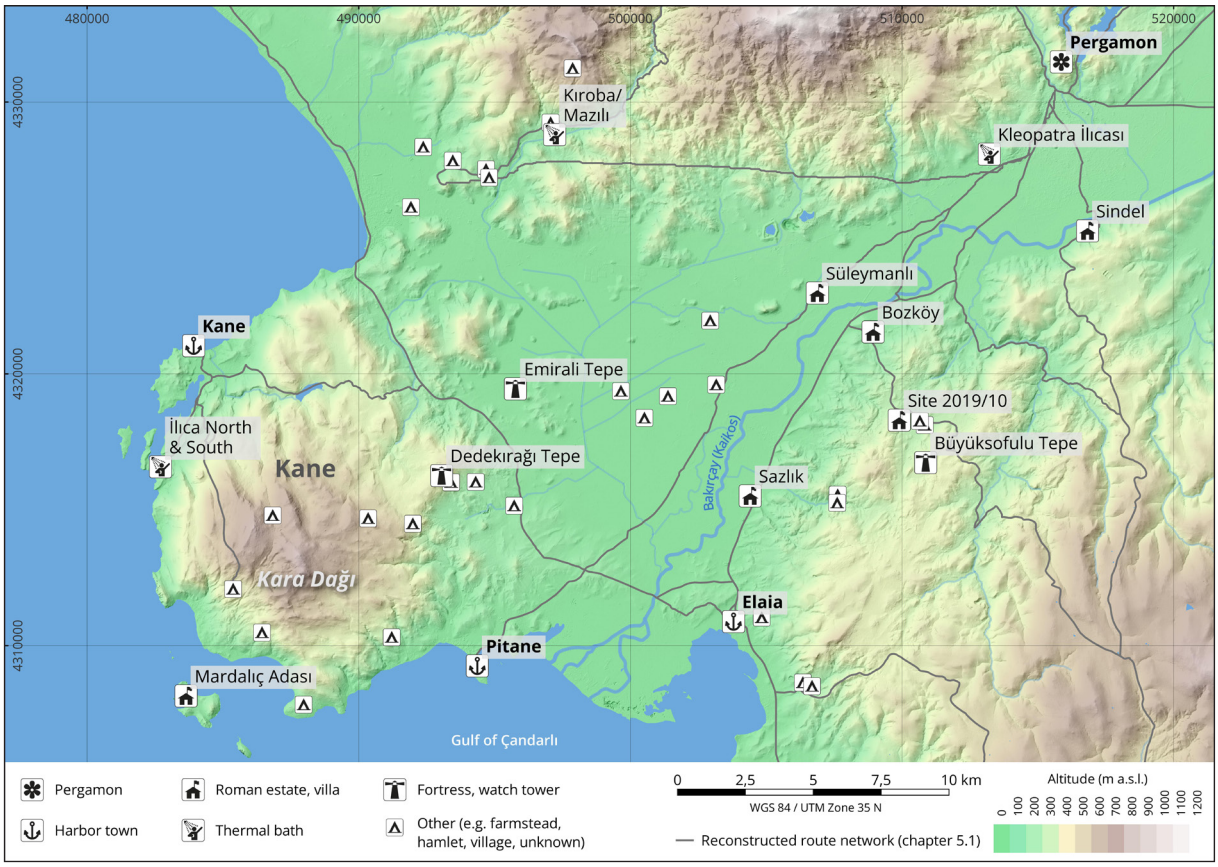

Fig. 6.3 The western Pergamon Micro-Region in the Roman Imperial period.

A transformative development of the settlement structure and changing needs between the Hellenistic and the Roman Imperial period, for example, could be demonstrated in chapter 5.2 using the three major harbor towns of Elaia, Pitane, and Kane as well as several small landing sites. While in Hellenistic times all harbors and landing sites along the coast were secured by watchtowers or fortresses, these disappear by the Roman Imperial period. Instead, thermal baths and seaside villas emerge and are built in other topographic locations, and at Pitane the harbor facilities that are being built indicate an expansion of trade capacities.

Additional archaeological evidence, especially for Roman estates and villas, has been provided by recent surveys.[708] These newly discovered estates are located in the intramontane Çalıbahçe basin (northwestern Yunt Dağı Mountains) and in the southern part of the western lower Bakırçay Plain – especially on the slightly elevated southern fringe of the plain, which protects against flooding events from the Bakırçay River. They are all related to the production of agricultural or ceramic goods and their location is oriented to fertile fields or raw material deposits, such as clay deposits in Bozköy.[709] On the Roman Imperial period map, their close relationship to the main transport axes between Pergamon and the harbor towns of Elaia and Pitane is clearly visible (Fig. 6.3). Bringing the case studies together thus provides new perspectives on certain aspects of the Pergamon Micro-Region, which are discussed in the following synopsis.

708 See appendix.

709 See appendix.

6.2 Aspects of a Transforming Micro-Region – A Synopsis

A diachronic synopsis of the case studies and surveys provides clear indications of a transformation of the settlement structure within the study period and potential answers to the question, raised as early as 1912 by C. Schuchhardt, of why the location of the later city hill of Pergamon within the landscape was chosen and finally developed to such a remarkable extent.[710]

Indications of a change in settlement structure, i.e., a concentration of settlements and a demilitarization from the end of the Attalid dynasty in 133 BCE to the Roman Imperial period, could already be observed on the basis of archaeological and historical evidence and are fundamental research aspects of the TransPergMikro project.[711] The comparison of the two maps of the western Pergamon Micro-Region in the Hellenistic period and the Roman Imperial period illustrates a fundamental change that was influenced by human-environment interactions, took place at different levels of the multi-layered micro-region (e.g., political, social, military, economic, and cultural), and manifested itself in the transformation of the rural settlement structure (Figs. 6.1, 6.3).

The reconstruction of the route network shows that Pergamon was well connected to regional and supra-regional transport and trade networks. Until now, it was nevertheless assumed that Pergamon's inland location away from the coast put it at an economic disadvantage compared to harbor cities such as Ephesus, since sea transport was cheaper and faster than land transport in antiquity.[712] From the perspective of the *longue-durée* and considering long-term environmental changes, however, a contrary view can also be argued. Pergamon secured access to the sea by developing the harbor of Elaia into its maritime satellite, i.e., its main civil and military harbor, probably already during the reign of Eumenes I in the mid-3rd century BCE.[713] In terms of its rural transport infrastructure, Pergamon was thus able to rely on a mixture of land and sea transport, similar to Ephesus. This promoted weather and seasonal independence and reduced the risk of massive constraints if a transportation route was blocked. The synthesis reveals another aspect that makes Pergamon's location and its strategy regarding maritime access appear advantageous over harbor cities: Although Elaia offered advantages to Pergamon over other harbor towns in the 3rd and 2nd centuries BCE due to its landscape position, building measures in the harbor and environmental changes in its hinterland led to a steady siltation of the harbor basin.[714] The resulting restriction of transport and trade capacity, however, had no discernible long-term disadvantages for Pergamon, which continued to grow in the Roman Imperial period. Compared to other ancient harbor cities on the west coast of Asia Minor that had to cope with shoreline displacements or rapid delta progradation, such as Ephesus or Miletus, Pergamon could react more flexibly to such

710 Conze 1912, 65 (C. Schuchhardt).

711 Pirson 2020, 156–159.

712 On the impact of Pergamon's location on its economic importance, see Halfmann 2001; Pirson 2008a, 33–34 with note 23; Knitter et al. 2013; Radt 2016, 17–20.

713 Pirson et al. 2015, 24; Feuser et al. 2020, 207.

714 Seeliger et al. 2013; Seeliger et al. 2017; Seeliger et al. 2019.

environmental changes.[715] Due to its position, there was always the option of switching to other nearby, already existing harbor locations that were well connected to the road network, especially the harbor of Pitane, which gained in importance during the Roman Imperial period, but also Kane or the possible harbor near ancient Atarneus and present-day Dikili.[716] For the latter, there were only a few references in written sources so far, but information on the exact location or archaeological evidence was missing. However, it has been shown that this place would have been a favorable landing site for Pergamon and the micro-region in terms of transportation and that it would have offered a serious alternative to the harbor towns located to the south.[717] In fact, only recently and after the publication of the study on the micro-region's maritime facade, archaeological remains were discovered in the shallow water that seem to confirm the existence of an ancient harbor in this area.[718] This fact demonstrates how the combination of archaeological and geoscientific methods can also be used to estimate potential locations and functions of ancient sites.

Geomorphological and sedimentological studies in the context of archaeological sites have shown that the Bakırçay Plain was continuously changing in the past and was an area of strong geomorphodynamics, i.e., such as repeated erosion and deposition shaping the terrain surface.[719] Archaeological surveys, however, provide evidence of settlement and land use of the western lower Bakırçay Plain in both the Hellenistic period and the Roman Imperial period (Figs. 6.1, 6.3). In addition, historical sources also describe the fertility and grain abundance of the plain.[720] Accordingly, although environmental changes influenced the development of the settlement structure in the western Pergamon Micro-Region, they by no means made settlement and land use impossible, at most restricting them somewhat temporarily or in certain areas. One example is a large estate near present-day Süleymanlı, in the western lower Bakırçay Plain. It was built on a slightly elevated location that was surrounded by channels and was most probably not affected by flood events of the Bakırçay River.[721]

The same applies to the development of the micro-region's route network. Probably at least since the Hellenistic period, the main road between Pergamon and Elaia ran along the southern fringe of the plain, which was slightly elevated and protected from flooding (Figs. 6.1, 6.3). Pergamon's supposedly disadvantageous scenic isolation from the sea and its inland location again did not offer any disadvantage in this context and can also be interpreted as an advantageous spatial situation. Parallel to the enormous urban growth of the city since the 1st century CE, settlement between Pergamon and Elaia along this

715 For a recent and general overview of environmental changes in Ephesus and Miletus, see, e.g., Brückner et al. 2014; Brückner et al. 2017; Brückner 2019; Stock et al. 2019.

716 See chapters 5.1 and 5.2.

717 See chapter 5.2.

718 T.C. Kültür ve Turizm Bakanlığı, İzmir 2 Numaralı Kültür Varlıklarını Koruma Bölge Kurulu 2021.

719 Schneider et al. 2013; Schneider et al. 2014; Schneider et al. 2015; Schneider et al. 2017; Becker et al. 2020; Pirson 2020, 223–227 (F. Becker – D. Knitter – X. Yang – B. Schütt); Pirson 2021a, 278–287 (F. Becker – X. Yang – M. Nykamp – M. Doğan – B. Schütt); Yang et al. 2023.

720 See, e.g., Sommerey 2008; Pirson – Zimmermann 2014.

721 Schneider et al. 2015; Pirson 2020, 224–225 (F. Becker – D. Knitter – X. Yang - B. Schütt); Pirson 2021a, 285–287 (F. Becker – X. Yang – M. Nykamp – M. Doğan – B. Schütt); Pirson (in press) (F. Becker – X. Yang – M. Doğan – M. Nykamp – B. Schütt).

main transportation axis was concentrated in a few large estates and villas with architectural ceramic, pottery (possibly only at a later stage), and agricultural production as well as proximity to agricultural land and raw material deposits in the adjacent Yunt Dağı Mountains (e.g., clay deposits near Bozköy). This ensured the effective exploitation of resources and production of goods necessary to satisfy the enormous urban and population growth and the accompanying demand for food, pottery, and building materials in Pergamon. The transport of these regional raw materials and products could be handled by the same transport infrastructure, with developed roads and bridges, as important imports (e.g., marble) shipped through the harbors in Elaia and Pitane. Thus, Pergamon's location within the landscape provided an important space along this corridor for the emergence of an economic agglomeration, i.e., an area where people, settlements, economic activity, and infrastructure were concentrated. It consisted of a cluster of several estates and production sites and was characterized by high land use and economic density in an otherwise sparsely populated micro-region. Potential owners of these estates could have been the landowning elite of Pergamon of that time.[722] This economic agglomeration benefited from its geographical location, the economic suitability of the area, and the development of the regional route network and was probably one of the motors of Pergamon's development in the Roman Imperial period.

The previously described economic agglomeration and intensive land use in the western lower Bakırçay Plain since the Roman Imperial period benefited from favorable natural conditions. In conclusion, however, with regard to the interactions between humans and the environment, the question arises as to what effect this intensification in turn had on the landscape.

Palynological studies from Elaia indicate a significant intensification of land use and a decline in forest cover in the western lower Bakırçay Plain as early as Hellenistic times.[723] Furthermore, a recent meta-study on the western lower Bakırçay Plain was able to show that geomorphodynamics were high during the study period and actually reached their maximum during the Roman Imperial period before decreasing again.[724] This trend thus corresponds spatially and temporally with the development of the economic agglomeration in the western lower Bakırçay Plain and Pergamon's increased demand for food, pottery, and building materials. A resulting reduction in forest cover in this area could therefore be a major reason for the increase in geomorphodynamics in the Roman Imperial period.

Evidence that this development most probably affected only the western lower Bakırçay Plain and the area around the economic agglomeration may be provided by a palynological study from Kara Göl Lake, which reconstructs a divergent vegetation and environmental history for the Kara Dağı Mountains. The landscape of the mountains was dominated by open deciduous oak forests between ca. 1550 BCE and 50 CE. In contrast to the plain, increased agricultural and pastoral activities were attested there for the period around 1500 BCE and from ca. 850–250 BC.[725]

722 See most recently Pirson 2020, 222–223 with further literature.

723 Shumilovskikh et al. 2016.

724 Becker et al. 2020.

725 Pirson 2021a, 300–309 (L. Shumilovskikh – M. Seeliger – H. Brückner).

Thus, spatially and temporally parallel trends of environmental changes and human settlement activities within the Pergamon Micro-Region could be shown on the basis of different sources. To what extent an actual causal connection between environmental changes and human settlement activities can be established and what influence the general climate variability had, however, must be shown by future research.

6.3 Conclusions

The aim of this thesis was to identify and interpret the interdependencies between the ancient city of Pergamon, other urban and rural settlements, and the landscape in the Pergamon Micro-Region. To this end, a landscape archaeological research framework has proven to be a valuable tool. Based on the category of micro-regions as a spatial and conceptual framework, as well as digital spatial analyses and archaeological surveys, it provided a systematic yet flexible approach to three case studies and their synthesis that took into account the diversity of a multi-layered micro-region. The chronological focus was set on the phase from the Hellenistic to the Roman Imperial period, i.e., from the 3rd century BCE to the 3rd century CE. For this phase, a fundamental change to urban Pergamon had already been described and initial evidence for a transformation of the rural settlement structure was available.[726] The latter can now be re-evaluated on the basis of the newly obtained results of this thesis.

The thesis presents how areas of the micro-region that were vital to the city of Pergamon as well as to its rulers and inhabitants were claimed, controlled, and secured through the placement of fortified settlements as early as the Hellenistic period.[727] The diachronic analysis also reveals how these settlements lost their function over time and thus provides clear evidence of a transformation of the settlement structure. Also, the great importance of the route network as the backbone of the micro-region and the basis of many developments in the rural area only became particularly clear through its first-time reconstruction. This network provides an important context for the diachronic interpretation and synthesis of the results obtained here, as well as for future research on Pergamon and its micro-region. The analysis of all harbors and landing sites along the maritime facade of the micro-region also revealed the changing needs of a transforming micro-region from military aspects in the Hellenistic period to trade and leisure in the Roman Imperial period.[728] Finally, the landscape provided natural conditions for the development of an economic agglomeration between Pergamon and Elaia, which most likely contributed significantly to meeting the rapidly increasing demand for food, ceramics, and building materials due to the growth of the city of Pergamon and its population during the Roman Imperial period. This development marks the preliminary end of a transformation of the rural settlement structure in the micro-region from a scattered settlement in the Hellenistic period to a clustering of large economic estates in the southern half of the western Bakırçay Plain, the adjacent foothills, and the intramontane basins of the Yunt Dağı Mountains.

In general, transformation processes cannot be controlled but only steered in a certain direction by socially accepted decisions.[729] For M. Zimmermann, adaptability to changes in external political, social, and economic conditions is therefore a decisive criterion for the success or failure of a micro-region.[730] Furthermore, adaptability to the natural environment and its changes must be added as an essential factor. Against this background, the following can be concluded:

726 Zimmermann et al. 2015; Pirson 2017.

727 A symbolic-mythological claim also occurred through the placement of rural sanctuaries. See most recently Pirson – Ludwig (in press) with further literature.

728 See also Pirson 2017, 112–113.

729 Deutsches Institut für Urbanistik 2017.

730 Zimmermann 2015a, 404.

The rural settlement structure of the Pergamon Micro-Region underwent a transformation while the city of Pergamon developed from an Attalid royal seat with supra-regional influence into a Roman metropolis with strong urban growth from the 1st century CE. The related and changing needs of the city of Pergamon, its rulers, and inhabitants are reflected in the rural settlement structure, e.g., in the number and distribution of fortresses, agricultural estates, or production sites. This reveals the close interdependencies between the city, other urban and rural settlements, and the landscape within the micro-region. The heterogeneous landscape provided essential natural conditions for dynamic adaptations to changing political and social conditions. Furthermore, Pergamon's position within this landscape offered the possibility of reacting flexibly to environmental changes, such as the steady silting up of its main harbor Elaia. The heterogeneous landscape of the micro-region and Pergamon's position within it thus offered greater independence from natural changes than other ancient (harbor) cities on the coast of Asia Minor enjoyed and thus contributed to the success of the Pergamon Micro-Region.

As a landscape archaeological study and with the conceptual framework of the micro-region, this thesis proves that it is possible, in close dialog with the available data, to arrive at interpretations at different scales and in a diachronic perspective that go beyond an individual city and the boundaries artificially set by merely geographical or historical-archaeological considerations.

With the consistent use of open-source software and the transparent presentation of all analyses, this thesis also guarantees connectivity for further discussions and research relating to Pergamon. At the same time, it should provide motivation for the approach presented here to be applied to the micro-regions of other ancient cities in Asia Minor and beyond in order to arrive at comparative studies with a regional or supra-regional focus in the future. Although the data bases are generally not very congruent, the great potential of such studies for the understanding of ancient cities and micro-regions has already been implied at some points in the synthesis.

Furthermore, this comprehensive landscape archaeological study of the Pergamon Micro-Region tries to set another milestone in the more than 140-year history of the study of this historical landscape by modifying the understanding of the micro-region and its role in the history of the city of Pergamon. It is, however, not the end but rather only a stage on the way to a more complete understanding of the multi-layered Pergamon Micro-Region.

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M. Zimmermann, Epilog: Neue Perspektiven der Stadtforschung: Städtische Physiognomien am Horizont der Mikroregion, in: A. Matthaei – M. Zimmermann (eds.), Urbane Strukturen und bürgerliche Identität im Hellenismus, Die hellenistische Polis als Lebensform (Heidelberg 2015) 400–405

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Appendix – Supplementary Publications

A.1 Erkundung weiterer Fundplätze im westlichen unteren Tal des Kaikos

B. Ludwig – F. Pirson, Erkundung weiterer Fundplätze im westlichen unteren Tal des Kaikos (Bakır Çay), in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2017, Archäologischer Anzeiger 2018/2, 167–168

A.2 Die Arbeiten des Umland-Surveys 2018

B. Ludwig, Die Arbeiten des Umland-Surveys 2018, in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2018, Archäologischer Anzeiger 2019/2, 113–126

A.3 Die Arbeiten des Umland-Surveys 2019

B. Ludwig – Z. M. Aksan – F. Pirson, Die Arbeiten des Umland-Surveys 2019, in: F. Pirson, Pergamon – Das neue Forschungsprogramm und die Arbeiten in der Kampagne 2019, Archäologischer Anzeiger 2020/2, 205–223

A.4 Die Arbeiten des Umland-Surveys 2020

B. Ludwig – F. Pirson, Die Arbeiten des Umland-Surveys 2020, in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2020, Archäologischer Anzeiger 2021/2, 258–268

Appendix – Figures

In these publications, tables are designated as figures.

A.1 Erkundung weiterer Fundplätze im westlichen unteren Tal des Kaikos

Published manuscript (own contribution 50 %):

B. Ludwig – F. Pirson, Erkundung weiterer Fundplätze im westlichen unteren Tal des Kaikos (Bakır Çay), in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2017, Archäologischer Anzeiger 2018/2, 167–168

DOI: https://doi.org/10.34780/aa.v0i2.1015

Im Rahmen der laufenden Vorbereitungen für ein neues Forschungsprojekt zur Transformation der Mikroregion Pergamon zwischen Hellenismus und römischer Kaiserzeit wurde mit der systematischen Erkundung bekannter Fundplätze im westlichen unteren Tal des Kaikos und der angrenzenden Seitentäler begonnen (Abb. A1.1). Diese Vorarbeiten, die im Jahr 2018 fortgesetzt und abgeschlossen werden sollen, dienen u. a. einer ersten Einschätzung der Fundplätze für ihre Eignung zur Anwendung eines interdisziplinären Forschungsdesigns.

Beim Dorf Kıroba nordwestlich von Dikili (Abb. A1.1) wurden im Arpalık Dere die bekannten Reste einer römischen Therme erneut aufgesucht (Abb. A1.2).[731] Die Fundstelle erstreckt sich entlang des Flußbetts über mehrere Olivenhaine und Felder, die durch Gestrüpp, Mauern und dorniges Astwerk voneinander abgetrennt sind. Es fanden sich noch mehrere Caementitium-Baukörper, ein durch eine Raubgrabung freigelegter Mauerzug, Bauglieder aus Andesit sowie Streuungen und Ansammlungen von Keramik- und Ziegelfragmenten und Andesitbrocken. Die Keramik reicht durchgehend von der frühen Kaiserzeit bis in das 7. Jh. n. Chr.[732] Die Baureste sowie Flächen für zukünftige geophysikalische Prospektionen wurden kartiert.

Reste eines römischen Großbaus westlich des Dorfes Sindel am Südrand des Tals des Bakır Çay (Kaikos) unweit von Pergamon (Abb. A1.1, A1.3) sind bereits im frühen 20. Jahrhundert als mutmaßliche Therme angesprochen worden.[733] Auf den benachbarten Äckern gab es wenig Keramik- und Ziegelfunde. Oberhalb der modernen Fahrstraße waren ein mutmaßlich antiker Weg und in dessen Umfeld zahlreiche Keramikstreuungen zu beobachten. Die Keramik datiert von späthellenistischer Zeit bis in die späte Kaiserzeit, daneben treten vereinzelt byzantinische und osmanische Scherben auf. Die Baureste sowie Flächen für zukünftige geophysikalische Prospektionen wurden kartiert.

Etwa 1 km südwestlich des Dorfes Karahıdırlı wurden auf einem großen, freistehenden Felsen antike Mauern und eine Zisterne beobachtet (Abb. A1.1, A1.4). Vermutlich handelt es sich um die Reste einer hellenistischen Warte.

731 Pirson 2010, 175 (M. Zimmermann).

732 Die vorläufige Bestimmung der Keramikfunde erfolgte durch G. Ateş (Manisa).

733 Conze 1912, 129–130 (C. Schuchhardt).

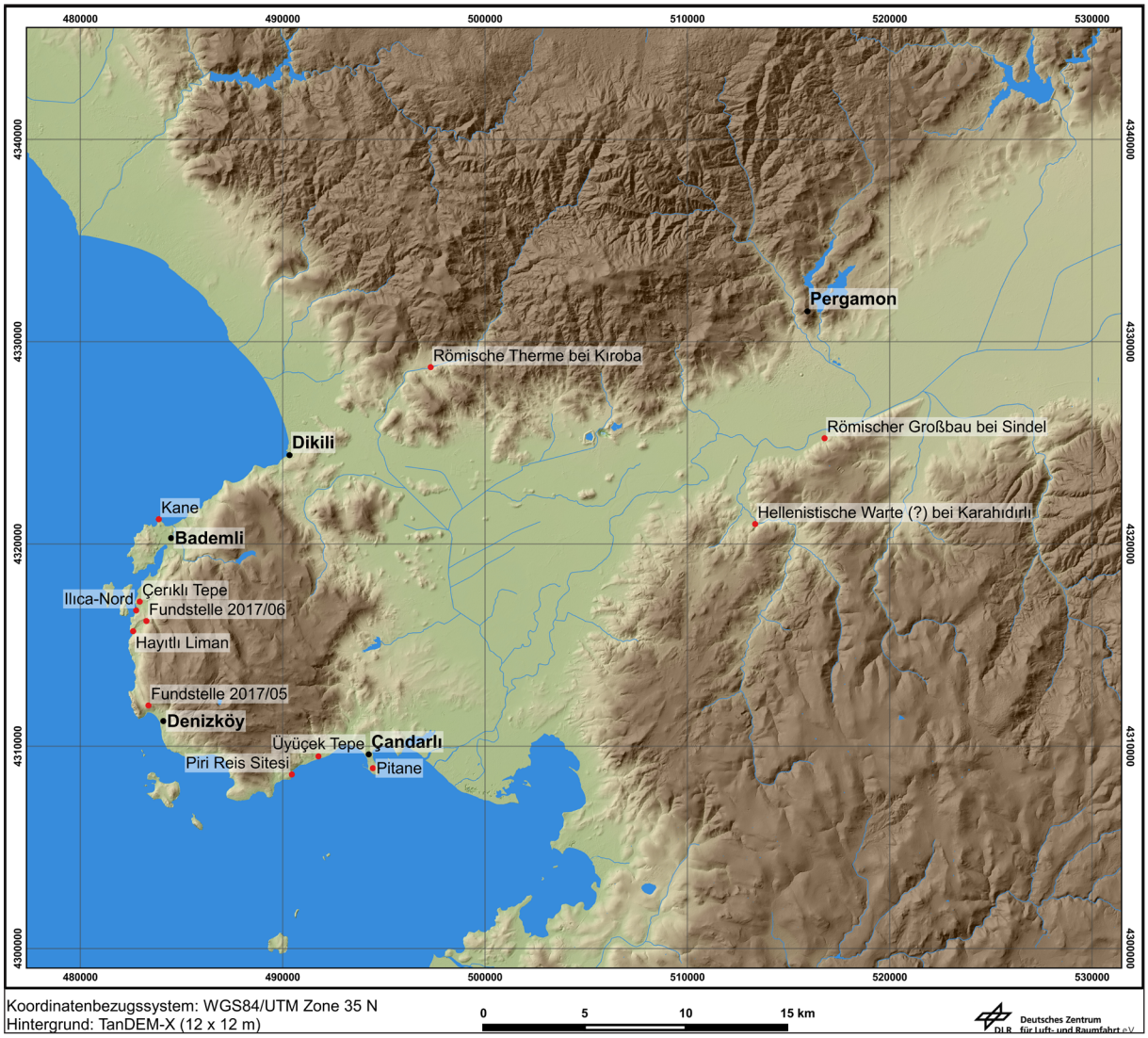

Abb. A1.1 Pergamon, Umland. Lage der im Jahr 2017 bearbeiteten Fundplätze.

Abb. A1.2 Pergamon, Umland. Römische Baureste (Therme?) bei Kıroba, Ansicht eines Gewölbes aus Opus caementitium von Norden.

Abb. A1.3 Pergamon, Umland. Römische Baureste (Therme?) bei Sindel, Ansicht eines Mauerstücks aus Opus caementitium von Süden.

Abb. A1.4 Pergamon, Umland. Befestigter hellenistischer (?) Platz bei Karahıdırlı, Zisterne.

A.2 Die Arbeiten des Umland-Surveys 2018

Published manuscript (own contribution 100 %):

B. Ludwig, Die Arbeiten des Umland-Surveys 2018, in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2018, Archäologischer Anzeiger 2019/2, 113–126

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Der mit unterschiedlichen Schwerpunkten konzipierte Survey 2018 im Umland von Pergamon arbeitete in einem Zeitraum von vier Wochen an insgesamt 15 Fundstellen, die auf drei regionale Arbeitsgebiete verteilt waren (Abb. A2.1).[734] Arbeitsgebiet 1 umfasste die nördlichen Ausläufer des Yünt Dağ-Gebirges und die südlichen Seitentäler des westlichen unteren Kaikostals um den Durdağ Tepe zwischen den Dörfern Çalıbahçe und Zeytindağ. Die Arbeiten dort galten dem Auffinden antiker Orte mit Sichtverbindungen in das Kaikostal und zu anderen, bereits bekannten Fundstellen. Im Rahmen der Untersuchungen zu Sichtverbindungen und sogenannten visual regions war dieses Gebiet bisher ein ‚weißer Fleck', der durch gezielte Feldbegehungen gefüllt werden sollte.[735] In Arbeitsgebiet 2, dem Gebiet der Kane-Halbinsel, wurde mit derselben Zielstellung gearbeitet. Arbeitsgebiet 3 umfasste das südliche Kozakgebirge in der Umgebung des Dorfes Çakırlar mit dem Ziel, die Überreste sogenannter Warten und Befestigungen zu (re)lokalisieren. Diese sollen zukünftig in einer Studie zu Kommunikationsnetzwerken innerhalb der Mikroregion Pergamon weiter untersucht werden. Die durch die Feldbegehungen neu entdeckten Fundstellen wurden zum Teil nur vorläufig dokumentiert, da sie im Rahmen des 2019 beginnenden neuen Forschungsprogramms ausführlicher untersucht werden sollen. Die Arbeitsgebiete wurden extensiv begangen, wobei topographische Besonderheiten, Berichte früherer Expeditionen und Hinweise der lokalen Bevölkerung die Grundlage zur Orientierung bildeten. Die im Rahmen des Umland-Surveys 2018 untersuchten Fundstellen werden im Folgenden vorgestellt.

Fundstelle 2018/01 – Kleine Siedlung/Gehöft

Auf einer kleinen Hochebene, ca. 2 km südwestlich des Dorfes Çalıbahçe und 1,8 km östlich von Tekkedere, liegt die Fundstelle 2018/01 (Abb. A2.1). Die Ebene ist von höheren Bergen umgeben und geht nach Süden in ein kleines Tal über, das sich in seinem weiteren Verlauf bei Tekkedere zum Tal des Kaikos (Bakırçay) hin öffnet. Im Laufe der Begehung wurden insgesamt vier Mauerzüge (001–004) entdeckt, die wahrscheinlich zu unterschiedlichen Gebäuden gehören. Mauer 001 liegt im Süden der Ebene,

734 Die diesjährigen Arbeiten im Umland von Pergamon konzentrierten sich auf exponierte Plätze, die für Sichtverbindungen und visuelle Kommunikation in der Mikroregion von besonderer Bedeutung sind (Im Rahmen der Studien von Christina Williamson (Groningen) und des Dissertationsvorhabens von Bernhard Ludwig (Istanbul), letzteres gefördert von der Deutschen Forschungsgemeinschaft.). Weiteres Augenmerk lag auf historischen Wegeführungen sowie auf Plätzen, die im Rahmen des Langfristvorhabens ‚Die Transformation der Mikroregion Pergamon zwischen Hellenismus und römischer Kaiserzeit' intensiv erforscht werden sollen.

735 Williamson 2016.

Abb. A2.1 Pergamon, Umland. Westliches unteres Kaikostal mit angrenzenden Gebirgen und Kane-Halbinsel. Karte mit den Fundstellen der Kampagne 2018

besteht aus Lesesteinen und konnte auf einer Länge von 3 m mit einer WNW-OSO-Orientierung aufgenommen werden. Weiter nordöstlich befindet sich eine auf 8 m erhaltene zweischalige Mauer (002) aus Lesesteinen mit der gleichen Orientierung (Abb. A2.2). Eine weitere Mauer (003), auf ca. 3 m erhalten, konnte wenige Meter weiter nördlich mit einer NNW-SSO-Orientierung lokalisiert werden. Mauer 004 liegt etwas nordwestlich, abseits der anderen Befunde und ist äußerst schlecht erhalten. Die Fundstelle ist zunächst nur anhand von Ziegelfragmenten auf einem Wirtschaftsweg erkennbar und bietet insgesamt nur sehr wenig Fundmaterial. Die vorläufige Datierung der Ziegel- und Keramikfragmente sowie die Befundsituation deuten auf eine Siedlung oder ein Gehöft aus kaiserzeitlich-byzantinischer Zeit hin.[736]

Abb. A2.2 Yünt Dağ, Fundstelle 2018/01. Mauer 002, Ansicht von Osten

736 Die Datierung des gesamten Survey-Fundmaterials durch Anneke Keweloh-Kaletta (Berlin) und Güler Ateş (Manisa) erfolgte an meist ungewaschenem Material und ist insofern nur vorläufig. Eine systematische Auswertung des Fundmaterials ist für die Kampagne 2019 vorgesehen.

Fundstelle 2018/02 – Kuyulu Kaya Tepe – Befestigung und Siedlung

Am Ende eines Seitentals des Kaikos, etwa 1,8 km östlich von Tekkedere, liegt Fundstelle 2018/02, der Kuyulu Kaya Tepe (Abb. A2.1). Hierbei handelt es sich um eine ca. 40 m hohe Felsformation, die im Süden von einem Fluss durchbrochen wird und äußerst steile Felswände besitzt (Abb. A2.3). An den anderen Seiten ist der Felsen von flachen Hängen umgeben, die heute zum Olivenanbau genutzt werden. Das Felsplateau ist nicht größer als ca. 20 m × 20 m und nur von Nordosten auf einem schmalen Kletterpfad zu erreichen. Vom Plateau aus bietet sich nach Westen ein ausgezeichneter Blick in das Kaikostal. Insgesamt zwei Zisternen (001–002) und eine große Felsabarbeitung, bei der es sich möglicherweise um eine dritte Zisterne (003) handelt, befinden sich auf dem Plateau. Zisterne 001 ist in den Felsen geschlagen, rund und läuft nach unten birnenförmig auseinander. Der obere Durchmesser beträgt 1,5 m, der untere ca. 3 m bei einer Tiefe von etwa 4 m. Die Zisterne ist mit einem noch sehr gut erhaltenen Putz abgedichtet. Zisterne 002 liegt im östlichen Teil des Plateaus und ist rechteckig. Sie wurde ebenfalls aus dem Felsen geschlagen und misst ca. 3,5 m × 2,5 m bei einer Tiefe von etwa 4 m (Abb. A2.4). Die gesamte Tiefe konnte nicht bestimmt werden, da der Boden von Schutt – auch infolge von Raubgrabungen – und Steinversturz bedeckt ist. Überreste an den Wänden weisen darauf hin, dass auch diese Zisterne verputzt war. An der westlichen Wand sind Abarbeitungen, vermutlich Auflager für Balken oder Steine, zu sehen. Im südlichen Bereich des Plateaus liegt ein etwa 7 m × 3,5 m großes Loch, möglicherweise eine Zisterne, die jedoch z. T. verschüttet und zudem schlecht erhalten ist.

Am östlichen Fuß des Felsens konnten weitere Befunde lokalisiert werden, die hauptsächlich durch Raubgrabungen zutage getreten sind. Bei Befund 005 handelt es sich um eine Bestattung. Erkannt wurde das Grab nur, weil alle Knochen des Individuums von den Raubgräbern in der zerwühlten Grube belassen wurden. Eine Grabeinfassung oder die ursprüngliche Lage des Individuums konnten nicht mehr nachvollzogen werden. Die Erhaltung der Knochen war aber ungewöhnlich gut, so dass nach einer ersten Aufnahme einige Aussagen zum Individuum getroffen werden konnten.[737] Aus der mutmaßlichen Grabgrube konnte das Fragment der Basis einer Terrakotta-Statuette geborgen werden, auf der auch noch die

Abb. A2.3 Yünt Dağ, Fundstelle 2018/02 – Kuyulu Kaya Tepe. Blick von Westen auf die Fundstelle

Abb. A2.4 Yünt Dağ, Fundstelle 2018/02 – Kuyulu Kaya Tepe. Zisterne 002 auf dem Felsplateau

737 Pirson 2019, 128–131 (W.-R. Teegen).

Spitzen zweier Füße erkennbar sind. Vorläufig kann von einer späthellenistischen bis frührömischen Bestattung ausgegangen werden; diese Einschätzung soll mithilfe einer Radiocarbondatierung des Skeletts überprüft werden.

In einer von mindestens zwei weiteren Raubgrabungen (006–007) konnten noch Befunde entdeckt werden. Es handelt sich dabei um ca. 0,7 m × 0,7 m große Quaderblöcke, die ursprünglich wohl in einem Verband lagen. Da sich die Raubgrabung 006 an einem leichten Geländeversprung befindet, könnte es sich um die Reste einer massiven Terrassierungsmauer handeln.

Am südlichen Fuß der Felsformation wurden einige behauene Quaderblöcke verschiedener Größen in Halden aus Steinversturz entdeckt. Diese Halden und vor allem die Quaderblöcke stammen vermutlich von einer Bebauung auf dem Felsplateau, die nach Süden abgerutscht ist. Putzanhaftungen an einigen der Blöcke lassen eine Zugehörigkeit zu den Zisternen auf dem Plateau vermuten. In der steilen südlichen Felswand befinden sich einige natürliche Höhlen, bei deren Begehung zunächst jedoch keine weiteren Funde oder Befunde wie z. B. Abarbeitungen entdeckt werden konnten.

Die Ausdehnung der Fundstelle wurde anhand der oberflächig sichtbaren Ziegel- und Keramikfragmente ungefähr bestimmt. Sie zieht sich über mehrere Terrassen und Olivenhaine mehr oder weniger vollständig um den Kuyulu Kaya Tepe herum.

Im Bereich des Felsplateaus, um die Bestattung herum und im übrigen Bereich der Fundstelle wurde zur chronologischen Einordnung Keramik aufgesammelt. Die Keramik aus dem Bereich der Raubgrabungen konnte vorläufig als hellenistisch bis kaiserzeitlich bestimmt werden. Im weiteren Bereich am Fuße des Kuyulu Kaya Tepe fanden sich hauptsächlich kaiserzeitliche Funde sowie zwei bronzezeitliche Keramikfragmente mit polierter Oberfläche. Auf dem Felsplateau wurde hingegen fast ausschließlich Keramik aus byzantinischer Zeit gefunden. Zwei Reibsteinfragmente aus Andesit wurden ebenfalls dokumentiert, aber am Ort belassen.

Bei Fundstelle 2018/02 handelt es sich aufgrund der bislang bekannten Fund- und Befundsituation wohl um eine Befestigungsanlage auf dem Felsplateau mit mindestens zwei großen Zisternen, die bis in byzantinische Zeit – oder vielleicht auch erst in nachantiker Zeit? – intensiv genutzt wurde. Am Fuße des Felsens befand sich offenbar eine kleine ländliche Siedlung mit einer Nutzungsdauer, die mindestens von hellenistischer Zeit bis in die Spätantike reichte. Ihre Ausdehnung konnte bislang nur ungefähr erfasst werden. Die vorläufige Auswertung der Fundkeramik deutet am besonders auffälligen Kuyula Kaya Tepe auf einen Siedlungsbeginn bereits in der Bronzezeit hin.

Fundstelle 2018/03 – Wasserleitung

Bei Fundstelle 2018/03 handelt es sich um eine wohl antike, zum Teil unterirdische Wasserleitung. Sie befindet sich am Rande eines Olivenhaines an der Straße von Bozköy nach Koyuneli (Abb. A2.1). Die Wasserleitung, die heute noch etwas Wasser führt, wurde deshalb in den letzten Jahren an einer Stelle ‚angezapft'. Hierzu wurde die Decke der Leitung aufgebrochen und mit neuen Steinen nach oben hin aufgemauert. In diesem Zustand wird sie heute wohl als Brunnen genutzt. Die Leitung verläuft von Südwesten kommend nach Nordosten und tritt etwa 20 m weiter in einem mit Schilf bewachsenen Graben wieder zutage. Östlich des Brunnens, im Olivenhain, finden sich zahlreiche Ziegel- und

Keramikfragmente, die jedoch nicht aufgesammelt wurden. In den umliegenden Gebäuderuinen sind Spolien verbaut, so dass hier vermutlich auch von einer antiken Siedlungstätigkeit auszugehen ist. Etwa 200 m nordwestlich der Leitung befindet sich ein großer aus Lesesteinen gesetzter Brunnen.

Fundstelle 2018/04 – Büyüksofulu Tepe – Befestigung

1,4 km südöstlich des Dorfes Çalıbahçe liegt neben dem Küçüksofulu Tepe der Büyüksofulu Tepe (Fundstelle 2018/04), ein am Fuß ca. 500 m × 300 m umfassender und rund 100 m hoher Berg, der heute von Ackerflächen und Olivenhainen umgeben ist (Abb. A2.1). An seinem steilen Westhang ist er von Bäumen und Buschwerk bedeckt, Nord- und Südhang sind etwas flacher, aber ebenfalls bewachsen. Nur der Osthang und Bereiche des Südhangs zeigen weniger Vegetation und sind deutlich flacher. Das Gipfelplateau ist mit ca. 20 m × 20 m verhältnismäßig klein. Nordöstlich davon schließt sich einige Meter unterhalb eine schmale Felsterrasse (10 m × 30 m) an. Vom Gipfelplateau kann man sowohl das östlich als auch das westlich zum Kaikostal verlaufende Tal einsehen. Außerdem sind größere Bereiche des Kaikostales selbst, z. B. Teuthrania (Kalerga Tepe)[738], gut zu sehen. Richtet man den Blick weiter nach Norden und Nordosten, hat man einen guten Blick zum Serhat Tepe sowie zum Stadtberg von Pergamon.

Bei der Begehung von Südosten aus wurden zunächst Keramikfragmente und schließlich insgesamt vier eindeutige Mauerbefunde entdeckt und dokumentiert (Abb. A2.5, A2.6). Mauer 001 ist eine ca. 8 m lange, noch dreilagig erhaltene Mauer aus ca. 0,5 m großen, unregelmäßigen Andesitbrocken. Hierbei handelt es sich vermutlich um Reste einer Terrassierungs- oder Befestigungsmauer. Südöstlich davon wurde eine weitere Mauer (002) entdeckt. Sie ist ebenfalls aus größeren Steinen gesetzt, zweischalig und 1,5 m bis 2 m breit. Diese Mauer konnte auf 6 m Länge verfolgt werden. Sie befindet sich an einem Geländeversprung und ist Bestandteil einer Terrassierungs- oder Befestigungsmauer. Auf dem Gipfelplateau wurde ebenfalls eine Mauer (003) aus kleineren, behauenen Andesitblöcken entdeckt. Sie ist auf einer Länge von ca. 1 m nachvollziehbar und endet möglicherweise an einer Gebäudeecke. Aufgrund der Größe des Plateaus lässt sich hier ein Gebäudegrundriss von ca. 7 m × 7 m vermuten. Diese Befundsituation entspricht anderen Fundstellen im Umland von Pergamon, die als Warten angesprochen werden, z. B. Fundstelle 2017/05.[739] Auf der etwas niedriger liegenden Terrasse verläuft in NNW-SSO eine 1,5 m breite und mindestens 11 m lange Mauer (004) aus unbehauenen Andesitblöcken. Die Mauer kann vom Übergang des Plateaus zur Terrasse über einen großen Felsblock mit Abarbeitungen hinweg bis zum Ende der schmalen Terrasse verfolgt werden. Auf der gegenüberliegenden Seite der Terrasse sind größere Halden aus verstürzten Steinen zu erkennen, so dass davon ausgegangen werden kann, dass die Mauer die Terrasse umschloss. Weitere Halden an allen Hängen des Berges zeugen wohl vom Abrutschen der nahezu gesamten Architektur auf dem Plateau.

Unter den aufgesammelten Keramikfragmenten am Südhang befand sich unter anderem der Fuß einer Transportamphore mit einer Laufzeit vom 4.–2. Jh. v. Chr. Das übrige Fundmaterial datiert vorläufig in den Zeitraum vom Hellenismus bis in die römische Kaiserzeit.

738 Pirson 2009, 181–182 (M. Zimmermann); Pirson 2013, 117–119 (A. Grüner).

739 Pirson 2018, 161–164 mit Abb. 67–69 (S. Feuser – E. Laufer).

Betrachtet man die topographische Lage und die Befundsituation, so lässt diese am ehesten die Interpretation als eine Befestigung oder eine befestigte Siedlung, möglicherweise mit einem oder mehreren Befestigungsringen, zu.

Abb. A2.5 Yünt Dağ, Fundstelle 2018/04 – Büyüksofulu Tepe. Blick auf den Hügel von Südwesten, im Hintergrund das Tal des Kaikos (Bakrçay)

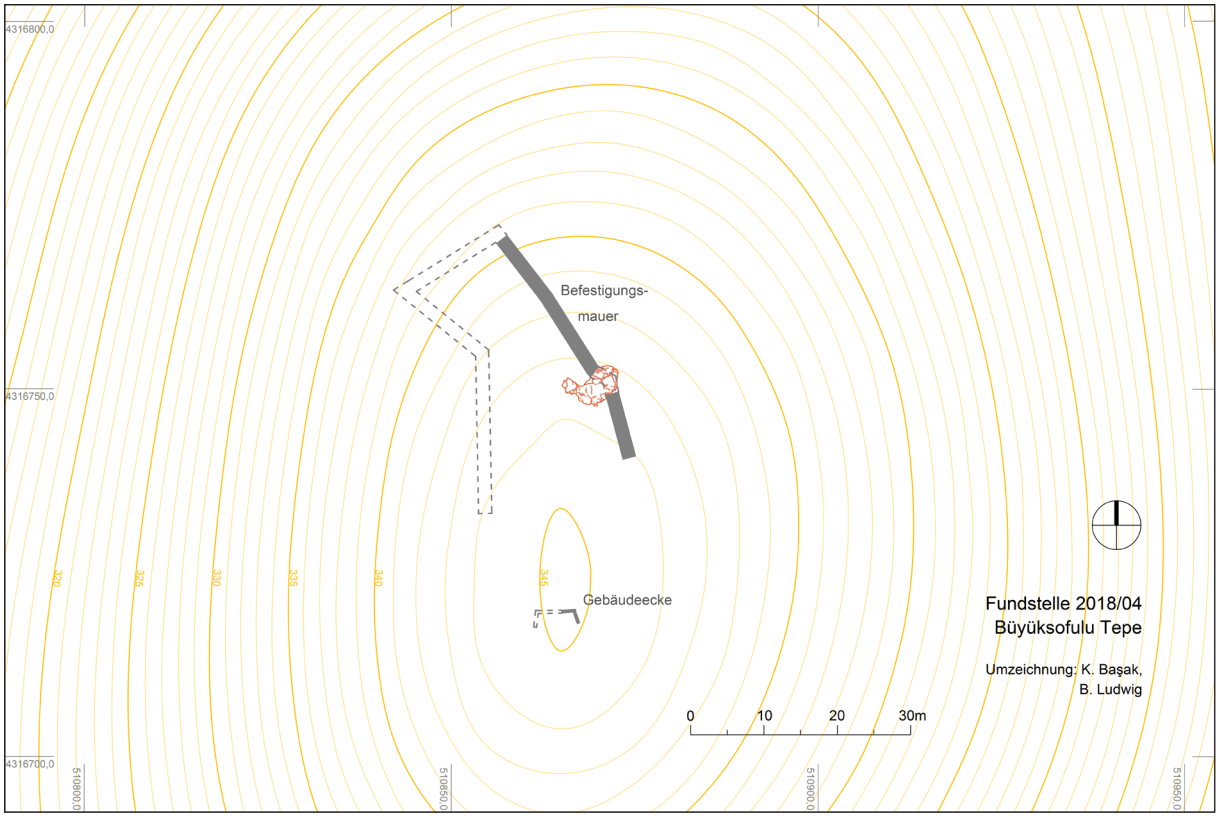

Abb. A2.6 Yünt Dağ, Fundstelle 2018/04 – Büyüksofulu Tepe. Plan der Fundstelle

Fundstelle 2018/05 – Mutmaßliche Warte

Fundstelle 2018/05 liegt auf der südlichen Kane-Halbinsel 0,6 km westlich der Feriensiedlung Çağdaş Siteler und 0,7 km nordöstlich der Siedlung Eyko Sitesi (Abb. A2.1). Sie befindet sich auf einer Hügelkuppe an den Hängen des Kara Dağ-Gebirges mit einem ausgezeichneten Ausblick bis nach Çandarlı (Pitane).[740] Inmitten von Geröll und großen Felsbrocken lassen sich auf der Kuppe mit Befund 001 die Reste einer Mauer, die der Überrest einer Warte sein könnte, lokalisieren. Es fanden sich jedoch weder Keramik noch Ziegel. Trockenmauern in der Umgebung sind mit großer Wahrscheinlichkeit jüngeren Datums. Es könnte sich hierbei aber aufgrund der topographischen Position um eine der von Carl Schuchhardt beschriebenen Warten handeln.[741]

Fundstelle 2018/06 – Kemikliburun – Befestigung/Warte und Siedlung/Gehöft

Kemikliburun bezeichnet eine Halbinsel, die den südwestlichsten Punkt der Kane-Halbinsel markiert und auf deren Geländerücken sich eine Fundstelle befindet (Abb. A2.1). Die Halbinsel liegt östlich der modernen Feriensiedlung Özlem Sitesi und ist nur wenig dicht bewachsen. Die Lage eignet sich ausgezeichnet, um die gesamte Küste mit ihren vorgelagerten Inseln, wie z. B. Mardaliç Adası[742], zu überblicken. Nach Norden reicht der Blick bis zum Maltepe bei Denizköy. Vom westlichsten Punkt der Halbinsel ist die Warte bei Denizköy (Fundstelle 2017/05)[743] zu sehen. Die unmittelbar nördlich angrenzende Bucht lässt sich von der Fundstelle aus ebenfalls bestens einsehen. Zwar ist Pitane nicht zu erkennen, jedoch die Bucht von Elaia.

Auf dem höchsten Punkt der Fundstelle finden sich über mehrere Terrassen verteilt antike Mauerbefunde, die von zahlreichen Trockenmauern vermutlich jüngeren Datums überlagert werden (Abb. A2.7, A2.8). Im Osten verspringt das Gelände an einer natürlichen Felskante um einige Meter. Darunter finden sich mehrere zum Teil rechteckige Mauerstrukturen. Vom höchsten Punkt aus zieht sich ein Höhenrücken etwa 600 m nach Westen. In diesem Bereich finden sich immer wieder Mauerbefunde, in der Regel neuzeitliche Hirtenhütten.

Der Kern der Fundstelle liegt am östlichen Ende des Geländerückens. Hier befinden sich zahlreiche Mauerzüge, die wohl antik sind und möglicherweise zu einem kleinen Gebäude (Turmgehöft?) gehörten. In diesem Bereich konzentrieren sich unzählige behauene Bauglieder, zumeist Quader verschiedener Größen, die alle eingemessen, photographiert und skizziert wurden. Die Kartierung verdeutlicht, dass hier ein möglicherweise hellenistisches Gebäude stand.

Um dieses Gebäude zu errichten, wurde das Gelände im Norden zum Teil künstlich terrassiert. Nach Osten hin bildet der anstehende Felsen eine natürliche Geländekante von mehreren Metern. Entlang dieser Kante erkennt man einen Steinversturz. Möglicherweise war diese Kante zusätzlich durch eine Mauer erhöht worden. Östlich vorgelagert liegen entlang der Kante zum Teil rechteckige Mauerstrukturen (002–009), die mit dieser Geländekante auch in Verbindung gebracht werden können. Geht man von

740 Pirson 2016, 181–184 (E. Laufer); Pirson 2018, 157–161 (S. Feuser – E. Laufer).

741 Conze 1912, 100–101 (C. Schuchhardt).

742 Hoffmann 1993; Pirson 2016, 180–181 (E. Laufer).

743 Pirson 2018, 161–164 (S. Feuser – E. Laufer).

Abb. A2.7 Kane-Halbinsel, Fundstelle 2018/06 – Kemikliburun. Plan der Fundstelle

Abb. A2.8 Kane-Halbinsel, Fundstelle 2018/06 – Kemikliburun. Luftbild der Fundstelle mit Blick nach Westen, im Hintergrund rechts die Insel Elaioussa (Mardaliç Adası)

einer befestigten Geländekante aus, könnte es sich hierbei um vorgesetzte Türme oder Verstärkungen gehandelt haben. Für ein freistehendes Gebäude erscheinen die Strukturen zu klein. Dem Verlauf nach Südosten folgend, zieht nach Südwesten über das Plateau eine massive Mauer aus großen Findlingen (1–1,5 m), die für eine reine Terrassierung überdimensioniert erscheint. Es könnte sich hierbei um die Fortsetzung einer Befestigungsmauer handeln, die den Kernbereich mit dem zuvor angesprochenen Gebäude schützte.

Auf der gesamten Fundstelle fanden sich viele Ziegel- und Keramikfragmente. Zunächst wurden nur einige Stücke zur Erstdatierung aufgesammelt: ein bronzezeitlicher Tripod Jar, zwei ESC-Kragenschüsseln (Mitte 2. Jh. n. Chr. bis 3. Jh. n. Chr.), zwei LRC-Bodenfragmente (425 bis 450 n. Chr.) und ein byzantinisches Fragment.

Um ein aussagekräftigeres Bild zur Ausdehnung und Datierung der Fundstelle zu erhalten, wurde ein intensiver Keramiksurvey durchgeführt, der sich methodisch an den in Pergamon bzw. Elaia erprobten Verfahren orientierte. In zwölf über die Fundstelle verteilten Planquadraten mit einer Größe von 1,5 m × 1,5 m wurden jeweils Keramik- und Ziegelfragmente gezählt. Außerdem wurde die Fundstelle in insgesamt acht Felder eingeteilt, die intensiv begangen wurden, um diagnostische Keramikfragmente aufzusammeln. Die Auswertung der Keramik und Fundverteilung ist für die Kampagne 2019 vorgesehen.

Vor diesem Hintergrund kann die chronologische Entwicklung der Fundstelle bislang nur umrissen werden. Aufgrund der Befundlage lässt sich aber an eine möglicherweise hellenistische Befestigungsanlage mit Mauerring und Turm denken, die den gesamten Schiffsverkehr um die Südwestspitze der Kane-Halbinsel sowie die nördlich gelegene Bucht kontrollierte. Von der römischen Kaiserzeit bis in byzantinische Zeit hinein könnte die Fundstelle als Siedlung oder Gehöft weiter genutzt worden sein. Vieh-, Oliven- oder Weinwirtschaft sind hier ebenso denkbar wie Fischerei von der nahegelegenen Bucht aus.

Fundstelle 2018/08 – Yazılı Taş Tepe – Warte

Die Fundstelle 2018/08 liegt auf einem kleinen, modern planierten Geländesporn, dem Yazılı Taş Tepe, direkt an einer modernen Straße durch die Siedlung Bimeyko Sitesi und zieht sich in südlicher Richtung leicht den Hang hinab (Abb. A2.1). Infolge moderner Planierungsarbeiten fanden sich überall Ziegel- und Keramikfragmente und vereinzelt behauene Blöcke verschiedener Größen. Auch in einer benachbarten Gartenmauer östlich des Areals sind einige antike Bauglieder verbaut worden. Bei der Fundstelle handelt es sich möglicherweise um eine der bereits von Schuchhardt beobachteten Warten.[744] Dafür spricht vor allem die Position im Gelände mit guter Sicht über die Südküste der Kane-Halbinsel, während die vorläufige Datierung der Keramik in die römische Kaiserzeit gegen eine militärische Nutzung spricht.

Fundstelle 2018/09 – Siedlung/Turmgehöft

1,5 km südwestlich des Dorfes Merdivenli nahe der Straße Kara Göl Yolu liegt am Ende eines nach Norden verlaufenden Tals auf einer kleinen Hochebene die Fundstelle 2018/09 (Abb. A2.1). Das Gebiet

744 Conze 1912, 100–101 (C. Schuchhardt).

ist überwiegend bewaldet, große Teile der Fundstelle sind jedoch offen und nur mit Gras bedeckt. Dieser Bereich ist großflächig mit Trockenmauern terrassiert worden.

Den Kern der Fundstelle bildet ein am Nordende der Ebene an einem Geländeversprung liegender Bereich mit verstürzten Steinen (Abb. A2.9). Darunter finden sich zwei Mauern (001), die eine Gebäudeecke bilden. Die anhand der Geländekante abgeschätzten Maße des Gebäudes von rund 7 m × 7 m erinnern an die Turmgehöfte in der Umgebung (s. o.). In diesem Bereich fanden sich außerdem zahlreiche behauene Quaderblöcke, die kartiert, photographiert und skizziert wurden und wahrscheinlich zu dem angesprochenen Gebäude gehörten. Weiterer Steinversturz in der Umgebung deutet auf kleinere Nebengebäude hin. Außerdem liegt westlich ein kleiner aus Steinen gesetzter Brunnen (002) mit einem Innendurchmesser von 0,8 m und einer Tiefe bis zur Oberkante der Verfüllung von 1,2 m. Diese Befunde werden möglicherweise von einer Mauer (004) umfasst, die sich an einigen Stellen noch nachvollziehen lässt und an einer Stelle wohl eine Zugangssituation besaß (003).

Südwestlich der Gebäude konnten drei weitere Brunnen dokumentiert werden. Brunnen 005, in dem auch im September noch Wasser steht, hat einen Innendurchmesser von 0,7 m und eine Tiefe bis zum Grund von 2,05 m. Brunnen 006 liegt weiter südwestlich, etwas abseits der Fundstelle im oben erwähnten terrassierten Gelände wenige Meter neben Brunnen 007. Brunnen 006 ist ebenfalls aus Steinen gesetzt, hat einen Innendurchmesser von 1,5 m und eine Tiefe von 2,95 m bis zum Grund. Brunnen 007, mit Abstand der größte Brunnen, liegt am südwestlichsten und hat einen Innendurchmesser von ca. 4–5 m und eine Tiefe von max. 6,4 m (Tiefe bis zum Wasser 4,6–4,8 m; Wassertiefe 1,6 m). Die Brunnen werden heute offenbar noch zum Tränken der Ziegen verwendet, ihr Alter lässt sich aber nicht ohne weiteres bestimmen.

Abb. A2.9 Kane-Halbinsel, Fundstelle 2018/09. Plan der Fundstelle

Betrachtet man die Befundsituation der Fundstelle, so ist hier am ehesten an eine landwirtschaftliche Siedlung bzw. an ein landwirtschaftlich genutztes Turmgehöft zu denken. Lage und Befunde erinnern an die in der Nähe liegenden Orte Asarlık Tepe[745] und Söğütlü Kalesi[746], die beide vermutlich landwirtschaftlich genutzte Turmgehöfte gewesen sind. Allerdings datiert die aufgesammelte Keramik dieser Fundstelle zunächst deutlich später, nämlich in spätantike bis byzantinische Zeit. Eine mögliche ältere Vorgängerbebauung und -nutzung kann zu diesem Zeitpunkt jedoch nicht ausgeschlossen werden.

Fundstellen 2018/10 und 2018/11 – Kilise Yeri und Karaca Kayası

Fundstelle 2018/10, Kilise Yeri (deutsch: Kirchplatz), liegt auf einem flachen Hügel 1,5 km südwestlich des Dorfes Çakırlar am Nordrand einer Hochebene, die sich nach Süden zum Kaikostal hin öffnet (Abb. A2.1). Es fanden sich moderne Trocken- und Terrassierungsmauern für Olivenhaine, aber auch einige ältere Bauglieder. Dabei handelte es sich um durchschnittlich 0,5 m × 0,5 m große Quaderblöcke von bis zu 1,4 m Länge sowie um einen 1,9 m großen Quader, der zu einem Tür- oder Torbogen gehörte. An einigen Stellen konnten auch noch Mauern in situ erkannt werden, die möglicherweise zu der namensgebenden Kapelle oder Kirche gehörten. Neben einigen wenigen Keramik- und Ziegelfragmenten wurden auch Steinfunde, wie z. B. eine große Reibschale, dokumentiert, die auf die landwirtschaftliche Nutzung der Hochebene hindeuten.

0,9 km südlich von Kilise Yeri liegt der Karaca Kayası, Fundstelle 2018/11 (Abb. A2.1, A2.10). Es handelt sich dabei um die von Schuchhardt beschriebene Fundstelle ‚41. Karadscha-Kaja bei Aladschalar'.[747] Die meisten von ihm beschriebenen Befunde konnten wiedergefunden werden, die Datierung in byzantinische Zeit wird sich anhand der gesammelten Keramik voraussichtlich bestätigen lassen.

Abb. A2.10 Kozak, Fundstelle 2018/10 – Kilise Yeri. Blick über die Hochebene zu Fundstelle 2018/11 – Karaca Kayası (Mitte rechts) und weiter in das Kaikostal

745 Pirson 2012b, 212–213 (M. Zimmermann).

746 Pirson 2012b, 211–212 (M. Zimmermann).

747 Conze 1912, 126 (C. Schuchhardt).

Vom Felsen aus hat man einen ausgezeichneten Blick über die gesamte Hochebene sowie in das Kaikostal mit dem Eğrigöl Tepe.[748] In der Ebene findet man heute nur noch einige Olivenhaine und Bienenstöcke. Insgesamt wird sie kaum landwirtschaftlich genutzt, der größte Teil liegt brach. Der von Schuchhardt beschriebene reißende Fluss führt heute, zumindest im Sommer, kaum Wasser.

Erwähnenswert sind die Lage der beiden Fundstellen auf der Hochebene sowie ihre Nähe zueinander. Schuchhardt stellte die Hypothese auf, dass es sich beim Karaca Kayası um das sogenannte Tiarai handeln könnte, das offenbar in dieser Gegend vermutet wird und in byzantinischer Zeit Bischofssitz gewesen ist.[749] Dazu würde der heutige Name ‚Kilise Yeri' der von Schuchhardt nicht erwähnten Fundstelle 2018/10 passen.

Fundstelle 2018/12 – Küçükburun/Yılanlı Tepe – Warte

Die Warte auf dem Yılanlı Tepe (Fundstelle 2018/12) ist bereits von Schuchhardt in ihrer Lage „am Geikli-Dag" ungefähr beschrieben worden.[750] Sie liegt 4,4 km nordwestlich des Dorfes Çakırlar auf einem Höhenrücken. Dieser trennt die beiden Täler, die nach Atarneus und über Kapıkaya nach Pergamon führen, voneinander (Abb. A2.1). Die Warte befindet sich somit an einer für die Verbindung zwischen Pergamon und Atarneus mit dem südlichen Kozakgebirge strategisch wichtigen Position. Leider zeigte sich sehr schnell, dass die Fundstelle durch Rodungs- und Wegebauarbeiten planiert worden ist, was eine detaillierte Befundaufnahme unmöglich machte. Zumindest war es möglich, die exakte Position der Fundstelle zu registrieren. Vor Ort konnten außerdem noch zahlreiche Ziegelfragmente, wenig Keramik und einige behauene Quader festgestellt werden. Mauern in situ waren nicht mehr auszumachen. Die Ausdehnung der Streuung wurde dokumentiert und die spätantiken bis osmanischen Funde aufgesammelt.

Fundstelle 2018/13 – Panayir Yeri Mevki – Siedlung/Gehöft

Die Fundstelle 2018/13 liegt 0,9 km westlich des Dorfes Yerlitahtacı und 1 km nordöstlich von Çakırlar auf einer ca. 100 m × 200 m großen, fruchtbaren Hochebene, die sich nach Südosten in Richtung des Stadtberges von Pergamon öffnet (Abb. A2.1). Die Ebene ist auch im Hochsommer erstaunlich grün und wird als Pferdeweide genutzt. Es handelt sich bei der Fundstelle vermutlich um eine kleine Siedlung oder ein (Turm-?)Gehöft, das am östlichen Rand der Ebene liegt. Moderne Trockenmauern erschweren die Identifizierung antiker Mauerstrukturen, dennoch sind einige antike Mauerzüge in situ erkennbar. Des Weiteren weisen Bauglieder, wie z. B. eine Säulentrommel aus Andesit und langrechteckige Quaderblöcke, sowie Keramik- und Ziegelfragmente auf eine antike Besiedelung hin (Abb. A2.11). Erwähnenswert ist auch der ausgezeichnete Ausblick auf den Stadtberg, der nur 5 km Luftlinie entfernt liegt (Abb. A2.12). Die Fundstelle konnte aus Zeitgründen nur sehr vorläufig dokumentiert werden. Sie passt aber gut in die Thematik des neuen Forschungsprogramms (s. o.), so dass ihre ausführliche Untersuchung im Rahmen der kommenden Feldkampagnen vorgenommen werden soll.

748 Pirson 2012b, 215–216 (M. Zimmermann).

749 Conze 1912, 127 (C. Schuchhardt).

750 Conze 1912, 127 (C. Schuchhardt).

Abb. A2.11 Kozak, Fundstelle 2018/13. Verstreute Bauglieder

Abb. A2.12 Kozak, Fundstelle 2018/13. Blick nach Südosten, im Vordergrund links die Häuser von Yerlitahtacı, rechts im Bild der Stadtberg von Pergamon und dahinter das Kaikostal sowie der Yünt Dağ

Fundstelle 2018/14 – Hacıismail Köprüsü – Brücke bei Demirtaş

Die zweibogige Brücke (Fundstelle 2018/14) führt über den Fluss Sarıasmak, der nur wenige hundert Meter von einer weiteren römischen Steinbrücke[751] entfernt in den Kaikos mündet. Die Brücke liegt 5,7 km südöstlich des Dorfes Demirtaş und 5,7 km südwestlich von Yenikent entfernt (Abb. A2.1). Der westliche Bogen der Brücke ist ca. 5 m hoch und überspannt den Fluss auf 11,2 m. Er ist damit deutlich

751 Pirson 2010, 197 mit Anm. 116.

größer als der östliche Bogen, der nur 4,8 m weit ist (Abb. A2.13). Die Brücke verläuft von West nach Ost über den Fluss, wobei sie auf Höhe des Mittelpfeilers leicht nach Norden abknickt. Die Brücke hat eine Breite von durchschnittlich 3,2 m. Die Reste einer Fahrbahndecke aus Beton und Zement zeigen, dass sie auch heute noch intensiv von landwirtschaftlichen Fahrzeugen genutzt wird. Der Unterbau der Brücke ist aus Quadern gesetzt und erscheint deutlich älter. Es handelt sich dabei vermutlich um Spolien, zum Teil auch aus Marmor. Die Brücke wurde vermutlich mehrfach wieder aufgerichtet, denn der Fundamentbereich, soweit er bis zur Wasseroberfläche sichtbar war, ist massiv gesetzt und scheint älter als die Bögen zu sein. An den Bogenansätzen lassen sich auch jeweils noch drei Balkenlöcher erkennen, die als Auflager für das Bogengerüst aus Holz dienten (Abb. A2.14).

Eine Datierung der Brücke ist nur schwer möglich. Sie könnte mehrmals repariert bzw. neu aufgesetzt worden sein. Möglicherweise hat sie antike Fundamente oder einen antiken Vorgängerbau, denn im Gegensatz zu Pfaden und Wegen haben Brücken in der Regel eine sehr hohe Ortskontinuität.

In der direkten Umgebung der Brücke fanden sich Quader, die vielleicht von einer Vorgängerbrücke oder der letzten Instandsetzung stammen. Anhäufungen antiker Ziegel sind am ehesten im Zuge der Bewirtschaftung der umliegenden Felder hier abgelagert worden.

Von Westen her führt eine mit Spolien gepflasterte Straße (002) auf die Brücke zu. Auf den letzten 200 m sind vor allem die Ränder im Feldweg erkennbar. Sie bestehen aus großen Andesit-, Kalkstein- und Marmorquadern, werden jedoch zunehmend durch das Pflügen der Baumwollfelder links und rechts des Weges zerstört. Dennoch ließ sich eine durchschnittliche Straßenbreite von ca. 2,9 m feststellen. Östlich der Brücke ist der Weg bislang nicht zu identifizieren. Eine erneute Begehung ist für das nächste Jahr vorgesehen.

Etwa 130 m nordöstlich der Brücke wurde bei der Begehung eine Ziegel- und Keramikstreuung (003) festgestellt. Die Funde datieren späthellenistisch, kaiserzeitlich und spätantik (bis in das 7. Jh. n. Chr.), wobei ein deutlicher Schwerpunkt auf der Kaiserzeit liegt.

Abb. A2.13 Westliches unteres Kaikostal, Fundstelle 2018/14 – Hacıismail Köprüsü. Brücke bei Demirtaş mit Blick nach Südosten

Abb. A2.14 Westliches unteres Kaikostal, Fundstelle 2018/14 – Hacıismail Köprüsü. Westlicher Bogen und Mittelpfeiler der Brücke

Raubgrabungen in Atarneus (Fundstelle 2018/07)

Während einer Exkursion nach Atarneus[752] wurden am Westhang des Siedlungshügels drei sehr große und relativ frische Raubgrabungen entdeckt. Ein Kapitell stellte in Raubgrabung 001 einen besonderen Fund dar, da Architekturteile für Atarneus ansonsten sehr selten sind. Das Objekt konnte jedoch nur photographiert werden und musste am Ort belassen werden. Die Sicherung des Fundstücks wurde durch das Archäologische Museum Bergama gewährleistet.

Elaia (Fundstelle 2018/15) – Raubgrabungen und Luftbilder der unter Wasser liegenden Mauerstrukturen

Elaia stand in diesem Jahr auf dem Programm des Surveys mit dem Ziel, Luftbilder von unter Wasser liegenden Mauerstrukturen aufzunehmen, die zu offenbar spätantiken Salinen gehören.[753] Diese Befunde sind im Rahmen des Elaia-Surveys in ihren Fluchten sowie in der Lage einzelner Quader vermessen worden. Die unter Wasser liegenden Mauern wurden mithilfe eines Quadrokopters aus der Luft aufgenommen. Dazu wurden sowohl Startpositionen vom Land als auch von einem kleinen Boot aus gewählt, da die Mauern teilweise viele hundert Meter auseinander lagen. Im Ergebnis sind Übersichtsfotos der Befunde entstanden (Abb. A2.15) sowie Detailansichten, die über den Aufbau der Mauern und Steinschüttungen Auskunft geben. Die Luftaufnahmen bilden zudem die Grundlage für eine präzisere Darstellung der Befunde im archäologischen Gesamtplan Elaias.

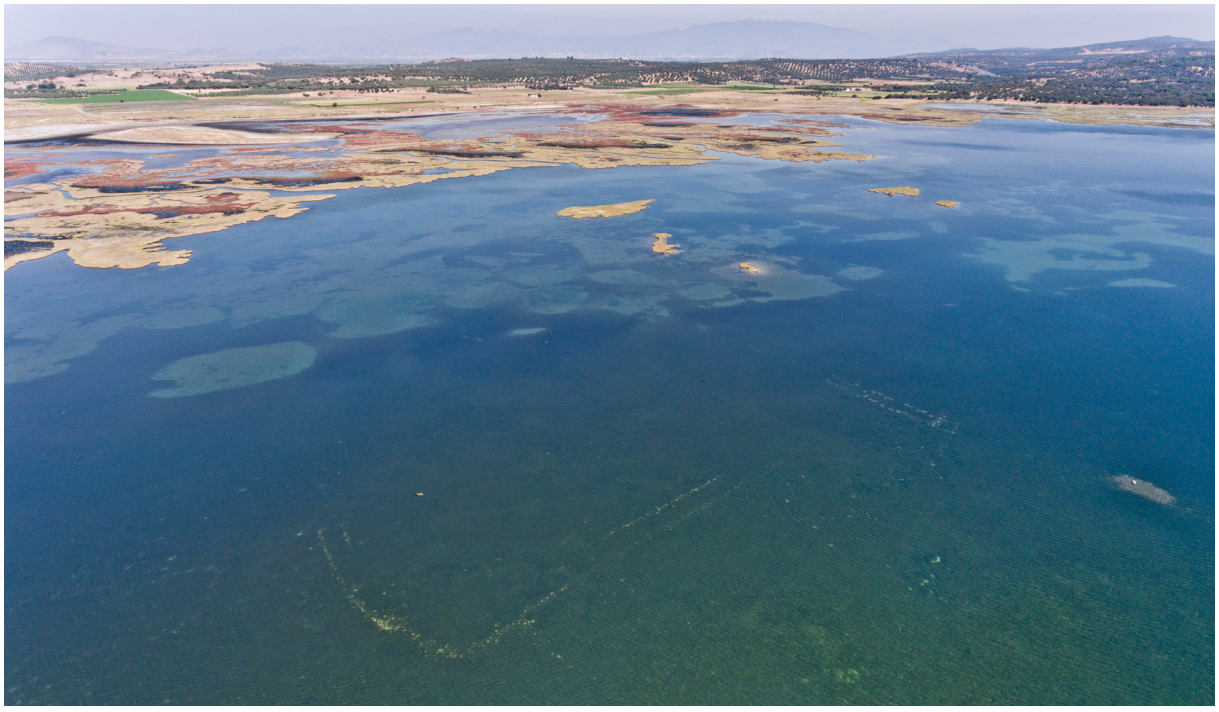

Abb. A2.15 Elaia, Vordergrund: Mauerstrukturen (Salinen) unter Wasser; Hintergrund halb rechts: Stadtgebiet mit Akropolis

752 Zimmermann et al. 2015 bes. 194–207.

753 Pirson 2011, 176–184 mit Abb. 105 (M. Seeliger – M. Bartz – H. Brückner); Pirson 2012b, 239 mit Abb. 136–138 (M. Seeliger – M. Bartz – H. Brückner).

Bei der Anfahrt zur Startposition für den Quadrokopter wurde zufällig eine umfangreiche Raubgrabung im Bereich der Nekropole etwa 40 m nordwestlich der Akropolis entdeckt. Dabei handelt es sich um zwei mit einem Kettenbagger ausgehobene Löcher, wobei das größere eine Ausdehnung von ca. 8 m × 4 m bei einer Tiefe von ca. 3 m hatte. Im Aushub fanden sich zwei Quaderblöcke, die zu einem Grab gehört haben könnten, das durch die Raubgrabung zerstört worden ist.

Im Westen von Elaia, wo die Stadtmauer obertägig sichtbar ist, fanden sich am Wegrand zahlreiche Stadtmauerblöcke (002). Einige Meter weiter nordöstlich wurde offenbar in jüngerer Zeit etwas Erde abgetragen, so dass ein weiterer Teil der Stadtmauer (003) sichtbar wurde, der in der kommenden Kampagne dokumentiert werden soll.

A.3 Die Arbeiten des Umland-Surveys 2019

Published manuscript (own contribution 65 %):

B. Ludwig – Z. M. Aksan – F. Pirson, Die Arbeiten des Umland-Surveys 2019, in: F. Pirson, Pergamon – Das neue Forschungsprogramm und die Arbeiten in der Kampagne 2019, Archäologischer Anzeiger 2020/2, 205–223

DOI: https://doi.org/10.34780/aa.v0i2.1025

Nach dem Abschluss der vorangegangenen Survey-Projekte im Jahr 2018 startete in diesem Jahr wieder ein archäologischer Umland-Survey im Rahmen des neuen DFG-Langfristvorhabens TransPergMikro[754]. Dem neuen Surveyprojekt, das sich zunächst auf das westliche untere Bakırçay-Tal (Kaikos-Tal) und die angrenzenden Gebirge Yunt Dağı, Kara Dağ und Kozak konzentriert, gingen Erkundungen und vorläufige Dokumentationsarbeiten dieser Region in den Jahren 2017 und 2018 voraus[755]. Zusammen mit den Ergebnissen der bisherigen Projekte und Forschungen im Umland von Pergamon bilden sie die Grundlage für den jetzt neu begonnenen Survey, dessen Ziel die Verdichtung der Informationen zur antiken Siedlungs- und Nutzungsgeschichte der Mikroregion Pergamon mit besonderem Schwerpunkt auf dem ländlichen Bereich ist[756].

Die diesjährigen Geländearbeiten konzentrierten sich auf zwei Survey-Areale (A und B) und mehrere zum Teil bekannte, aber wenig untersuchte Fundstellen (Abb. A3.1, A3.2). Das Survey-Areal A liegt 18 km südwestlich des Stadtberges von Pergamon beim Dorf Çalıbahçe in den Ausläufern des Yunt Dağı-Gebirges. Es umfasst ein Seitental der Bakırçay-Ebene, das nach dem Bach Tekkedere benannt ist und an dessen Ausgang ein Dorf gleichen Namens liegt. Zwischen den Dörfern Çalıbahçe und Bozköy formt das Geländerelief ein intramontanes Becken, das als Survey-Areal B in Ausschnitten begangen wurde.

Alle zugänglichen Flächen innerhalb der Survey-Areale wurden intensiv und systematisch begangen, d. h. in einem Abstand von 2,5 m zwischen den einzelnen Teammitgliedern. Dabei zeichneten GPS-Handgeräte die zurückgelegte Strecke auf. Alle Funde wurden mit Hilfe einer App auf Tablet-PCs dokumentiert. Neben der exakten Fundposition konnten dadurch zusätzlich eine einmalige Kennung, die Fundgattung, die Bodensichtbarkeit und etwaige Besonderheiten registriert werden. Datierende Funde wurden für die anschließende Auswertung im Grabungshaus aufgesammelt. Durch diese Begehungssystematik konnten Fundkonzentrationen, die Rückschlüsse auf Siedlungstätigkeiten erlauben, identifiziert werden und gleichzeitig ganze landschaftliche Einheiten in einem Gesamtkontext untersucht werden. Beim Antreffen starker Fundkonzentrationen in den Survey-Arealen oder auf bereits bekannten Fundstellen wurde ein Raster aus so genannten Zählfeldern angelegt. Das Raster bestand aus Zählfeldern von

754 Die Arbeiten dauerten vom 26.08.–02.10.2019. Zur Leitung Pirson 2020, Anm. 8, zu den Mitarbeiterinnen und Mitarbeitern Pirson 2020, § 243.

755 Pirson 2018, 167–168 (B. Ludwig – F. Pirson); Pirson 2019, 113–126 (B. Ludwig).

756 Siehe Pirson 2020, § 9–16.

1,5 m × 1,5 m in einem Abstand von 10 m zueinander. Diese Systematik wurde bereits im Rahmen früherer Surveys der Pergamongrabung angewandt und erlaubt deshalb eine projektübergreifende Vergleichbarkeit. Innerhalb der Felder wurden alle Funde nach Fundgattung getrennt gezählt und per App registriert. Mit Hilfe dieser Methode ließ sich die Ausdehnung der Fundkonzentrationen bzw. Fundstellen präzise dokumentieren. Die zeitliche Einordnung wurde durch eine parallel durchgeführte Begehung gewährleistet, bei der datierendes Material aufgesammelt wurde. Dieses System ist bereits in früheren Umland-Surveys eingesetzt worden und unterstützt damit nochmals die Vergleichbarkeit der Ergebnisse.

Die diesjährigen Geländearbeiten wurden zusätzlich durch geophysikalische Prospektionen[757] und geoarchäologische Untersuchungen[758] unterstützt. Erwähnenswert ist außerdem der enge Austausch mit der lokalen Bevölkerung, der gezielt im Gelände und in den umliegenden Dörfern gesucht wurde. Die Gespräche entwickelten sich zu einer wertvollen Informationsquelle bei der Erforschung der Region und förderten zugleich das Verständnis und die Akzeptanz der Arbeiten auf den Feldern und in den Olivengärten. Die Gespräche wurden zumeist filmisch und schriftlich dokumentiert, um sie als objektive Quelle für die Zukunft zu erhalten[759].

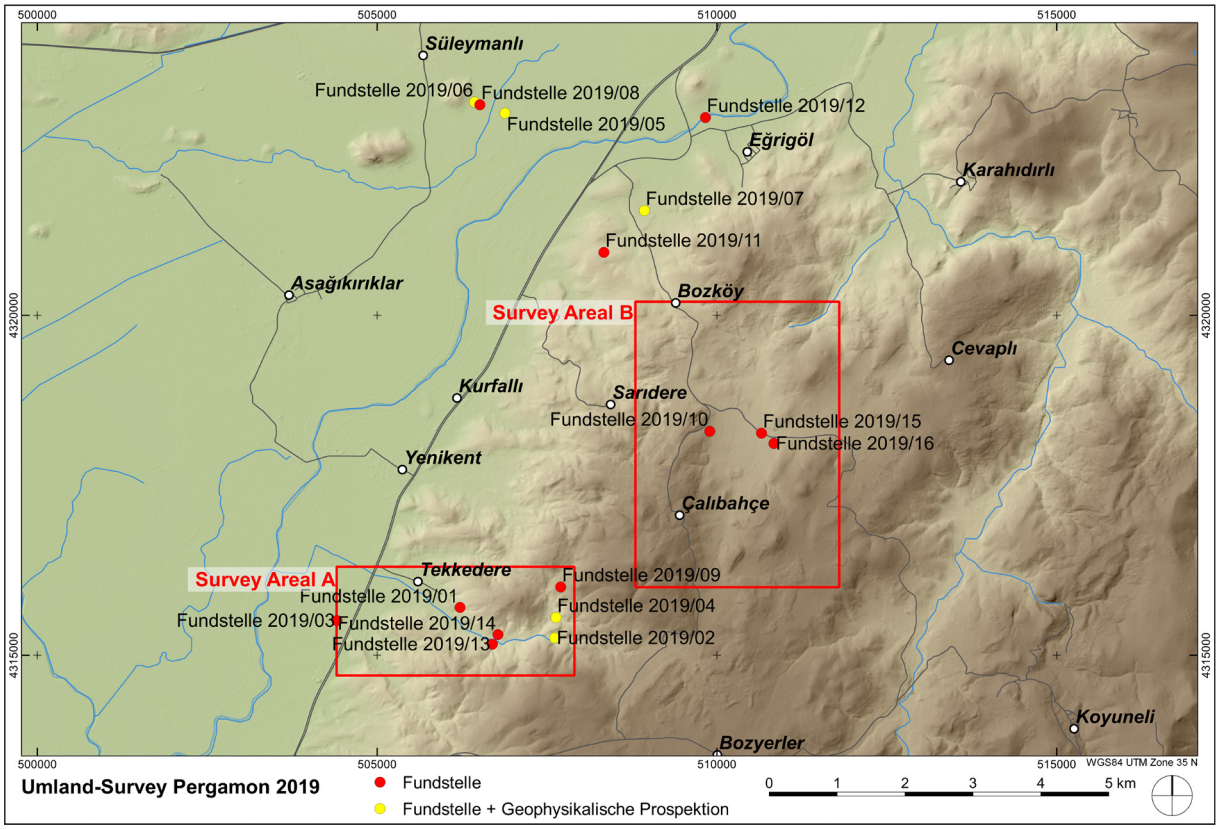

Abb. A3.1 Umland, Übersicht über die Fundstellen und Survey-Areale 2019

757 Siehe Pirson 2020, Anm. 5.

758 Siehe Pirson 2020, § 175–188.

759 Dieser Bereich wurde schwerpunktmäßig von Murat Tozan (Izmir) übernommen, der darüber hinaus auch osmanische Texte mit Bezug zum Untersuchungsgebiet systematisch unter archäologischen und althistorischen Aspekten auswertet und dem Projekt damit wichtige neue Quellen erschließt.

Survey-Areal	Fundstelle	Bezeichnung
A	Sy-Ar-A	Survey-Areal A (Tekkedere-Tal)
B	Sy-Ar-B	Survey-Areal B (Gebiet zwischen Çalıbahçe, Bozköy und Cevaplı)
A	2019/01	Eski Tekkedere (Vorgängersiedlung von Tekkedere)
A	2019/02	Kuyulu Kaya Tepe (entspricht 2018/02)
-	2019/03	Mutmaßliches antikes Gebäude (Badeanlage?)
A	2019/04	Siedlungsplatz nördlich des Kuyulu Kaya Tepes
-	2019/05	Gebäudekomplex mit Marmorausstattung
-	2019/06	Fundplatz westlich des Sultan Tepes (Tumulus?)
-	2019/07	Gebäudeensemble mit reicher architektonischer Ausstattung
-	2019/08	Felder bei 2019/06 (Prähistorische Fundstelle?)
A	2019/09	Yukarı Kışlak (Vorgängersiedlung von Tekkedere; entspricht 2018/01)
B	2019/10	Fundstelle zweier Mörser/Pressen bzw. Pressgewichte
-	2019/11	Harita Tepe (Osmanischer Friedhof)
-	2019/12	Überreste einer alten Brücke über den Bakır Çay südlich des Eğrigöl Tepe
A	2019/13	Fundstelle mit Keramik- und Ziegelkonzentration südlich von 2019/14
A	2019/14	Aşağı Kışlak (Vorgängersiedlung von Tekkedere)
B	2019/15	Fundstelle mit Keramik- und Ziegelkonzentration
B	2019/16	Fundstelle mit Keramik- und Ziegelkonzentration

Abb. A3.2 Umland, tabellarische Darstellung der Fundstellen und Survey-Areale 2019

Survey-Areal A – Tekkedere-Tal

Das Tekkedere-Tal erstreckt sich rund 3 km in einem Bogen von Nordosten nach Süden und weiter nach Nordwesten bis zum Übergang in das Bakırçay-Tal in der Nähe von Tekkedere (Abb. A3.1). Das Seitental wird vom gleichnamigen Bach durchflossen, der allerdings in den Sommermonaten vollständig austrocknet. Die höher gelegenen Hänge sowie die Höhenrücken am Rande des Tals sind von Kiefern und Pinien bedeckt. Auf den teilweise steilen Hängen und in der Talsohle befinden sich Olivengärten, die systematisch begangen werden konnten. Die im Survey-Areal A untersuchte Fläche beträgt damit insgesamt 75,28 ha. Auf dieser Fläche konnten insgesamt sechs Fundplätze entdeckt bzw. dokumentiert werden (Abb. A3.3).

Am nordöstlichen Talrand liegt auf einer zum Tal offenen Hochebene der Fundplatz Yukarı Kışlak (Fundstelle 2019/09 und 2018/01; Abb. A3.3)[760]. An der Oberfläche sind auf einer Länge von gut 100 m noch mehrere einzelne Mauerzüge verschiedener Gebäude sichtbar. Zu den bereits 2018 dokumentierten Überresten kamen in diesem Jahr noch die zweischaligen Mauern (50–70 cm breit) eines Gebäudes von 3 m Breite und 13 m Länge hinzu. Anhand des Fundmaterials lässt sich die Fundstelle möglicherweise

760 Pirson 2019, 114 (B. Ludwig).

in spätantike, sicher aber in byzantinische Zeit datieren[761]. Nach den Aussagen der lokalen Bevölkerung handelt es sich bei diesem Fundplatz um die älteste bekannte Vorgängersiedlung des heutigen Dorfs Tekkedere am Talausgang.

Bei Aşağı Kışlak (Fundstelle 2019/14) etwa in der Mitte des Tales (Abb. A3.3) soll es sich nach Aussagen Ortsansässiger um eine jüngere Vorgängersiedlung des heutigen Dorfes handeln. Bauliche Überreste konnten dort jedoch keine mehr entdeckt werden. Südlich und östlich des Platzes, also etwas hangabwärts, zeigen sich in der Kartierung der Keramikfunde (Abb. A3.4) aber dichte Keramikkonzentrationen, deren Ursprung in einer ehemaligen Siedlung liegen kann. Eine zeitliche Einordnung des Platzes war mangels datierbarer Stücke aus dem Bereich der Fundstelle bislang nicht möglich.

Die beiden erwähnten Fundplätze haben jedoch gemeinsam, dass sie ebenso wie die dritte und jüngste Vorgängersiedlung des Dorfes Eski Tekkedere (Fundstelle 2019/01) die einzigen nicht bewirtschafteten Brachflächen im Tal sind (Abb. A3.3). An dem Platz der Fundstelle 2019/01 befand sich bis in die Mitte des 19. Jahrhunderts das alte Dorf, bevor es nach einem Erdrutsch in Folge eines Erbebens rund 500 m weiter nordwestlich wieder aufgebaut wurde. Diese Fläche wurde nicht systematisch begangen, erwähnenswert ist jedoch ein aus kaiserzeitlichen Marmorspolien[762] gesetzter Dorfbrunnen, der noch an seinem Ursprungsort steht und dessen Bauglieder dokumentiert wurden. Weitere Spolien fanden sich an der Stelle der ehemaligen Moschee, darunter ein halbierter Grabaltar aus Marmor (121 cm hoch, 36 cm breit), dessen Seiten eine (antike) griechische Inschrift und eine Inschrift in möglicherweise armenischer oder georgischer Sprache tragen (Abb. A3.5). Von den Inschriften wurden Abklatsche angefertigt, bevor der Fund in das Museum Bergama gebracht wurde.

Als Herkunftsort der zahlreichen Marmorspolien sowohl im alten Tekkedere als auch im heutigen Dorf kommen das nahe gelegene Elaia oder die bislang noch nicht systematisch untersuchte Fundstelle 2019/03 1,4 km südwestlich von Tekkedere infrage (Abb. A3.1). Erwähnenswert ist ein ca. 50 cm großes, profiliertes Marmorfragment vermutlich aus nordafrikanischem ‚giallo antico', das am Feldrain aufgelesen wurde und vom Potential der Fundstelle zeugt, die in den kommenden Jahren intensiver untersucht werden soll.

Neben den drei Vorgängersiedlungen des heutigen Tekkederes befinden sich noch drei weitere Fundplätze im Tal. Die Fundstelle 2019/13 liegt auf einer kleinen Hügelkuppe (ca. 30 m × 30 m) an den Südhängen in der Mitte des Tales (Abb. A3.3). An der Oberfläche lassen sich weder Mauerreste noch eine besonders hohe Keramikdichte feststellen (Abb. A3.4). Allerdings wurde bereits im Gelände eine große Zahl an Ziegelfragmenten erkannt, die auch in der Kartierung aller Ziegelfunde aus dem Tal deutlich wird (Abb. A3.6).

Eine vergleichbar dichte Konzentration von Ziegelfragmenten ist im gesamten Survey-Areal A sonst nur auf Fundstelle 2019/04 anzutreffen (Abb. A3.3, A3.6). Dieser Platz zeichnet sich gleichzeitig durch eine dichte Keramikkonzentration aus (Abb. A3.4). Es handelt sich um einen ca. 10 m hohen Hügel mit einem ca. 30 m × 10–18 m großen flachen Plateau, dessen Fundmaterial von frühhellenistischer bis

761 Die Datierung des gesamten Survey-Fundmaterials erfolgte durch G. Ateş (Manisa) und A. Keweloh-Kaletta (Berlin).

762 Die Datierung der Bauglieder erfolgte durch K. Piesker (Berlin).

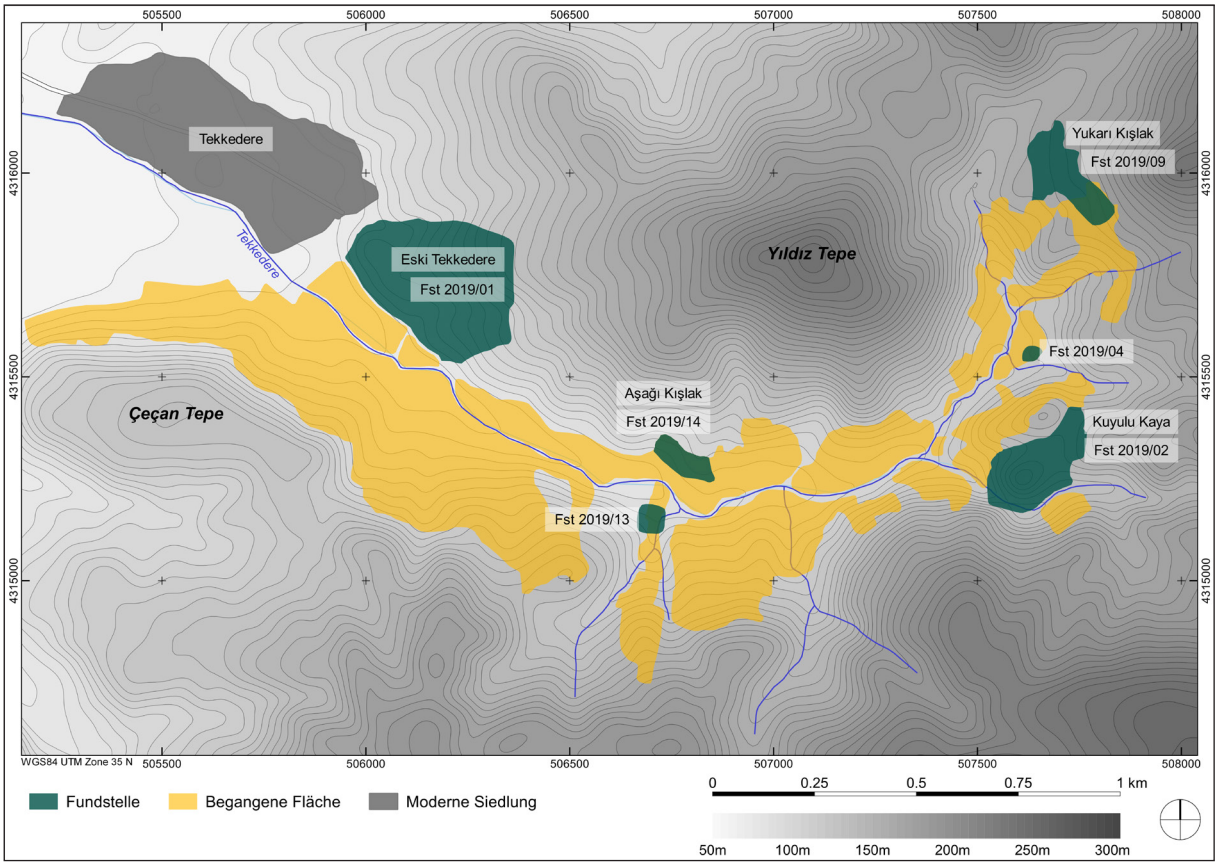

Abb. A3.3 Umland, Survey-Areal A. Übersicht über die begangene Fläche und die dokumentierten Fundstellen

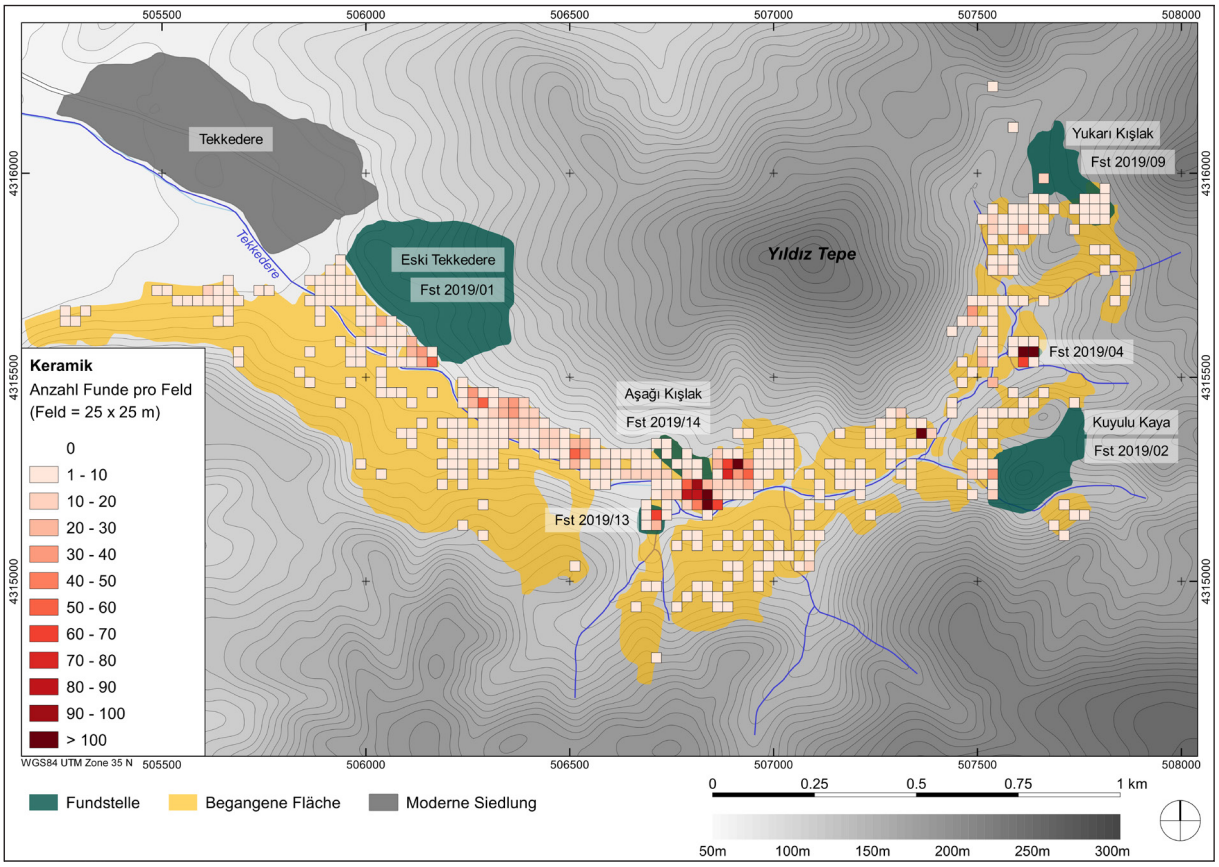

Abb. A3.4 Survey-Areal A. Kartierung aller Keramikfunde

in späthellenistischfrühkaiserzeitliche Zeit datiert. Hinweise auf antike Architektur auf diesem kleinen Hügelplateau liefern die oberflächlich sichtbaren Ziegel, eine am Fuß des Hügels gefundene steinerne Türschwelle sowie Anomalien in der Geomagnetik.

Abb. A3.5 Umland, Survey-Areal A. Fundstelle 2019/01 – Eski Tekkedere. Grabaltar aus Marmor mit Inschriften

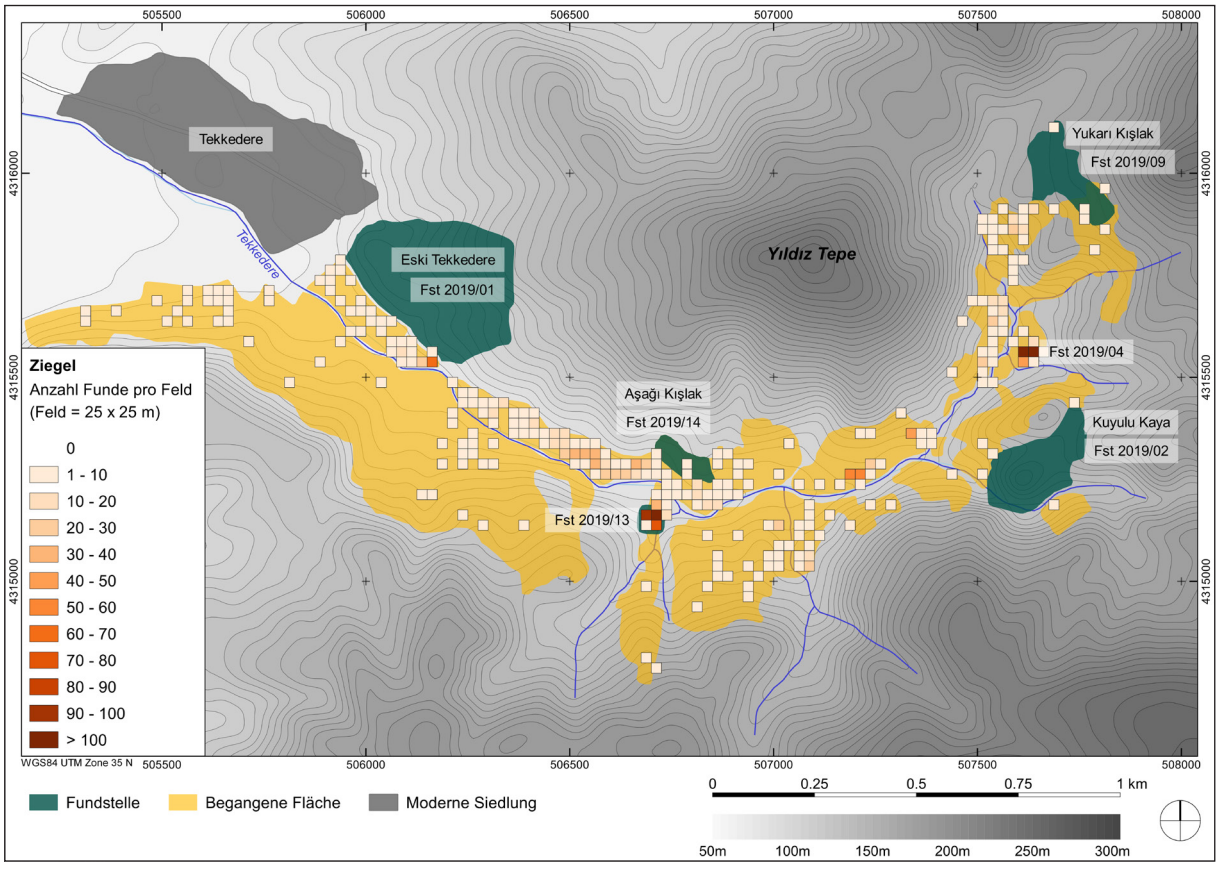

Abb. A3.6 Umland, Survey-Areal A. Kartierung aller Ziegelfunde

Die größte Fundstelle im Tal ist der bereits 2018 entdeckte Kuyulu Kaya Tepe (Fundstelle 2019/2 und 2018/02)[763]. Der Fundplatz liegt im Osten des Tales (Abb. A3.3) und wird von einem rund 40 m hohen markanten Felsen dominiert. Auf dem Felsplateau befinden sich insgesamt drei Zisternen, die in diesem Jahr abschließend dokumentiert werden konnten. Das geringe Fundmaterial, das in den Jahren 2018 und 2019 auf dem Felsplateau gefunden wurde, datiert in frühbyzantinische bis byzantinische Zeit. Östlich des Felsens schließen sich eine Geländeterrasse und ein Plateau an, das durch die umliegenden Hügel und einen tief in das Gelände eingeschnittenen Bach begrenzt wird. Seit 2018 war auf der Geländeterrasse eine durch eine Raubgrabung freigelegte Bestattung[764] sowie eine künstliche Terrassierung aus massiven Steinblöcken bekannt. Weitere architektonische Befunde im Untergrund der Terrasse und dem anschließenden Geländeplateau werden u. a. auch aufgrund einer ca. 12 m × 4,5 m großen Steinhalde im Südosten des Fundplatzes angenommen. Daher wurden auf der Geländeterrasse geoelektrische und auf dem Plateau geomagnetische Messungen durchgeführt, die jedoch durch die Vegetation beeinträchtigt wurden. Auch wenn keine detaillierten Aussagen zu einzelnen Anomalien getroffen werden können, liefern die Messungen dennoch Hinweise auf weitere Strukturen im Untergrund des Fundplatzes (Abb. A3.7, A3.8). Gleichzeitig wurde ein intensiver Keramiksurvey auf der Fundstelle durchgeführt, bei dem insgesamt 78 Zählfelder angelegt und datierendes Material aufgesammelt werden konnte. Die Kartierung der Ziegel (Abb. A3.8) zeigt auch unter Berücksichtigung der durch die Vegetation sehr unterschiedlichen Sichtverhältnisse innerhalb der Zählfelder eine deutliche Konzentration auf und unmittelbar um die Geländeterrasse im Bereich der Geoelektrik. Diese Verteilung ließe sich durch vom Felsplateau herabstürzende Ziegel oder durch Architektur auf der Terrasse erklären. Die Kartierung der Keramik weist ein etwas anderes Bild auf (Abb. A3.7). Auf der Geländeterrasse findet sich kaum Keramik, allerdings zeigt sich auf dem Plateau eine deutliche Keramikkonzentration, die möglicherweise im Zusammenhang mit Anomalien in der Geomagnetik steht. Das aufgesammelte Fundmaterial reicht von der Bronzezeit bis in spätbyzantinische Zeit.

Zusammenfassend ist für den Kuyulu Kaya Tepe eine festungsartige Bebauung des gesamten Plateaus anzunehmen, die zuletzt in byzantinischer Zeit genutzt wurde und von der das gesamte Tekkedere-Tal und große Teile des westlichen unteren Bakırçay-Tales überblickt bzw. kontrolliert werden konnten. Die Dachflächen dieser Gebäude sorgten gleichzeitig für die Füllung der Zisternen mit Regenwasser, wodurch eine langfristige Wasserversorgung des Siedlungsplatzes sichergestellt werden konnte. Am Fuß des Felsens befand sich eine kleine Siedlung, deren Nutzung über vier Jahrtausende hinweg belegt werden kann.

Für das Survey-Areal A und damit für das Tekkedere-Tal lässt sich eine nahezu ununterbrochene Siedlungskontinuität von der Bronzezeit bis in die heutige Zeit verfolgen. Die früheste Besiedlung kann anhand bronzezeitlicher Keramik am Fundplatz von Kuyulu Kaya Tepe nachgewiesen werden. Dieser Platz wurde frühestens in spätbyzantinischer Zeit aufgegeben und kann auch aufgrund seiner Lage als antike Hauptsiedlung des Tales gelten. In hellenistischer Zeit werden gleichzeitig der wenige hundert Meter nördlich gelegene Hügel (Fundstelle 2019/04) sowie möglicherweise auch die Fundstelle

763 Pirson 2019, 115–116 (B. Ludwig).

764 Zur Auffindungssituation: Pirson 2019, 115–116 (B. Ludwig); zur anthropologischen Auswertung: Pirson 2019, 129–131 (W.-R. Teegen).

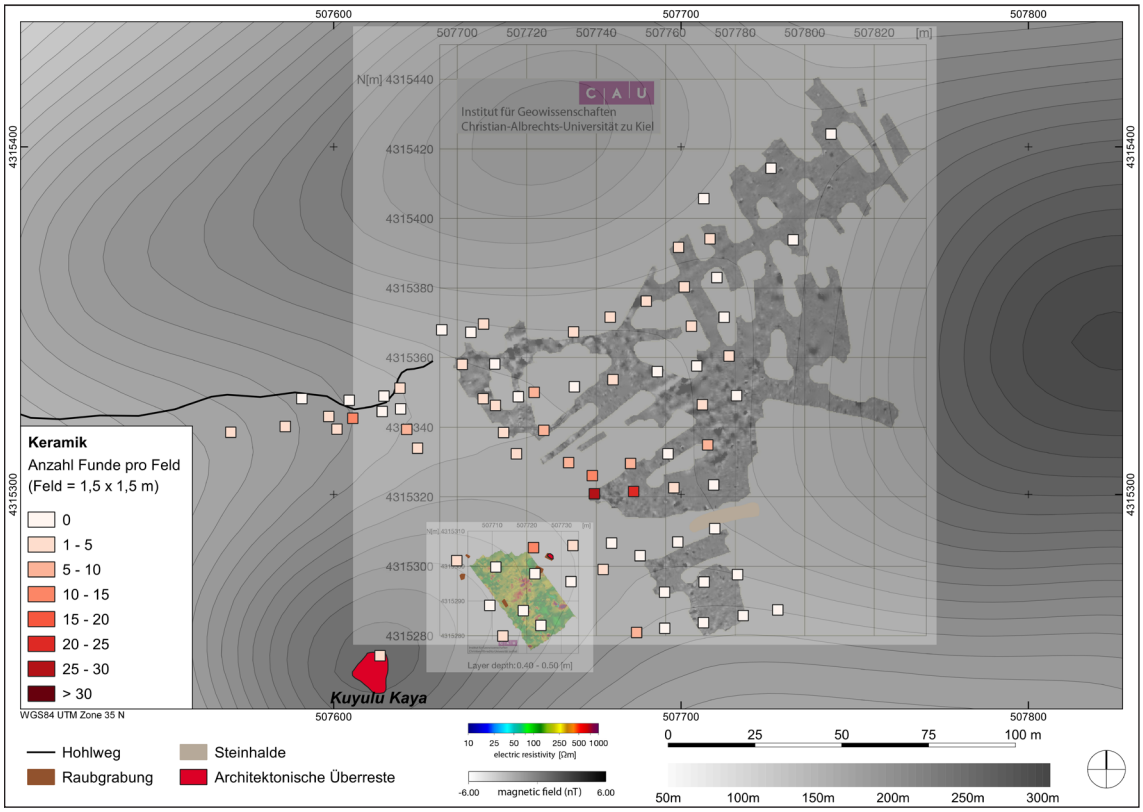

Abb. A3.7 Umland, Survey-Areal A. Fundstelle 2019/02 – Kuyulu Kaya Tepe. Kartierung aller Keramikfunde mit Geophysik (Geoelektrik, Geomagnetik)

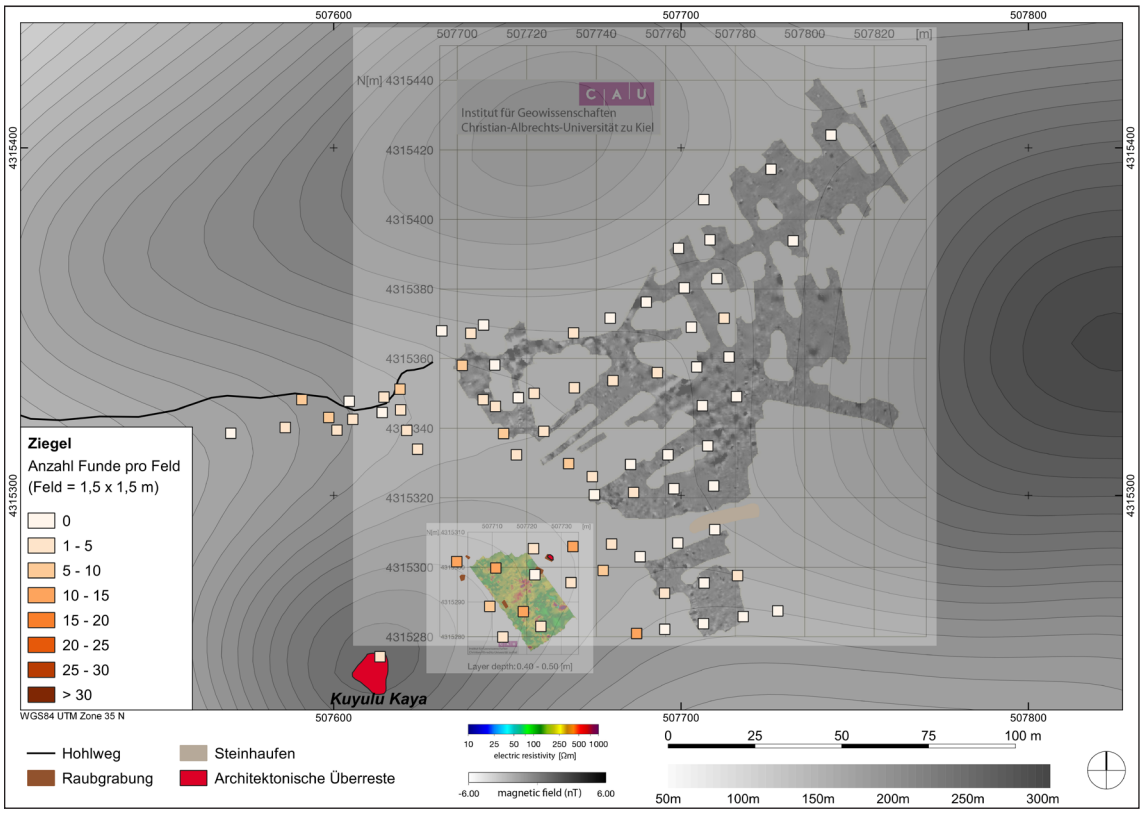

Abb. A3.8 Umland, Survey-Areal A. Fundstelle 2019/02 – Kuyulu Kaya Tepe. Kartierung aller Ziegelfunde mit Geophysik (Geoelektrik, Geomagnetik)

2019/13 besiedelt. In byzantinischer Zeit wird das Felsplateau des Kuyulu Kaya Tepes wohl als Festung genutzt, bevor der Platz schließlich aufgegeben wird und sich mit Yukarı Kışlak am nordöstlichen Talrand gleichzeitig eine neue Siedlung etabliert. Diese wird wohl später zugunsten von Aşağı Kışlak und wiederum später zugunsten von Eski Tekkedere, das bis in die Mitte des 20. Jahrhunderts existierte, aufgegeben.

Survey-Areal B – Intramontanes Becken bei Çalıbahçe

Zwischen den Dörfern Çalıbahçe, Bozköy und Cevaplı formt das Gelände angrenzend an die Yunt Dağı-Ausläufer ein Becken, das als Survey-Areal B begangen wurde (Abb. A3.1). Im Gegensatz zum engen Tekkedere-Tal, das ausschließlich durch Olivengärten geprägt ist, findet in diesem eher offenen Becken vornehmlich Ackerbau statt.

Das Survey-Areal B wurde so gewählt, dass im Rahmen des Surveyprojektes möglichst unterschiedliche landschaftliche Einheiten untersucht werden können. Aus Zeitgründen konnte im Survey-Areal B nur ein Korridor von Ost nach West durch das gesamte Becken mit einer Fläche von insgesamt 34 ha intensiv begangen werden. Doch bereits dabei zeichneten sich drei Fundkonzentrationen ab, die als Fundstellen definiert worden sind.

Fundstelle 2019/10 liegt an den östlichen Hängen des Kelimalan Tepes und zeichnet sich durch eine dichte Keramik- und Ziegelkonzentration (Abb. A3.9, A3.10) sowie zahlreiche Steinfunde aus. Neben mehreren Reibsteinen sind eine Presse oder ein Mörser (70 cm × 130 cm × 65 cm) und dessen Gegengewicht (40 cm × 80 cm × 70 cm) besonders erwähnenswert, die auf eine landwirtschaftliche Produktionsstätte schließen lassen. Das Fragment eines Mosaiks kann als Indiz für die gehobene Ausstattung der Anlage gewertet werden. Das überwiegende Fundmaterial datiert in die Zeit vom 1. bis 3. Jh. n. Chr. und im weiteren Umfeld des Fundplatzes wurde zudem fast ausschließlich späthellenistisches Material gefunden.

In den Kartierungen der Keramik und der Ziegel zeichnen sich noch zwei weitere Fundplätze deutlich ab (Abb. A3.9, A3.10). Fundstelle 2019/15 liegt direkt an einem Bach und erstreckt sich über eine Fläche von ca. 130 m × 100 m. Das Fundmaterial datiert etwa von klassischer Zeit bis in die Spätantike. Fundstelle 2019/16 liegt gut 100 m weiter östlich an einem leichten Hang und erstreckt sich auf ca. 220 m × 140 m. Hier datiert das gefundene Material in den Hellenismus und die römische Kaiserzeit. An keiner der beiden Fundstellen konnten außer Fundmaterial weitere oberirdisch sichtbare Strukturen erkannt werden.

Es bleibt festzuhalten, dass das Gebiet von Survey-Areal B wahrscheinlich über lange Zeit landwirtschaftlich genutzt wurde und durch seine Nähe zu Pergamon für dessen Versorgung eine Rolle gespielt haben könnte. Zudem wird das Gebiet in hellenistischer Zeit von den beiden Festungen auf dem Büyüksofulu Tepe[765] im Süden und dem Serhat Tepe[766] im Norden dominiert.

765 Pirson 2019, 117–118 Abb. 34, 35 (B. Ludwig).

766 Pirson 2012b, 213–214 Abb. 47 (M. Zimmermann); Pirson 2013, 121–123 Abb. 43 (A. Matthaei).

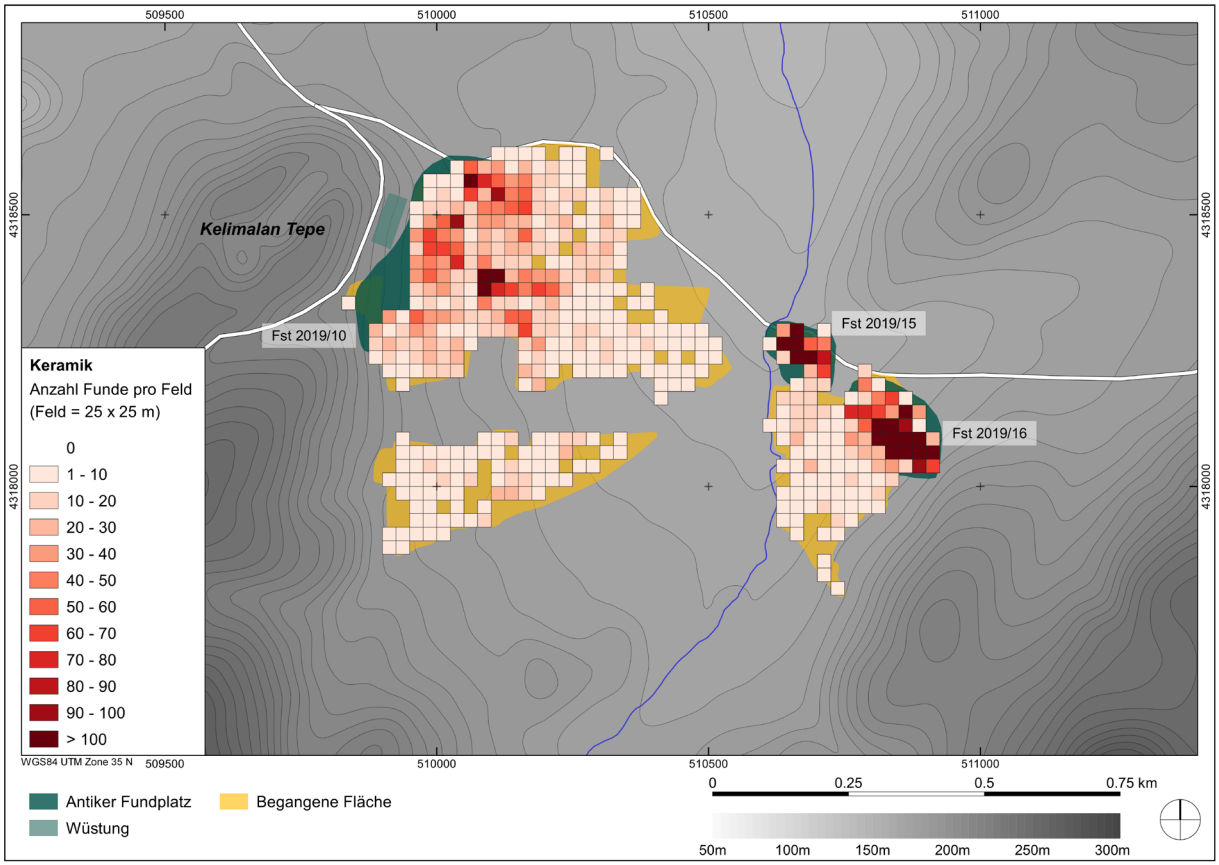

Abb. A3.9 Umland, Survey-Areal B. Kartierung aller Keramikfunde

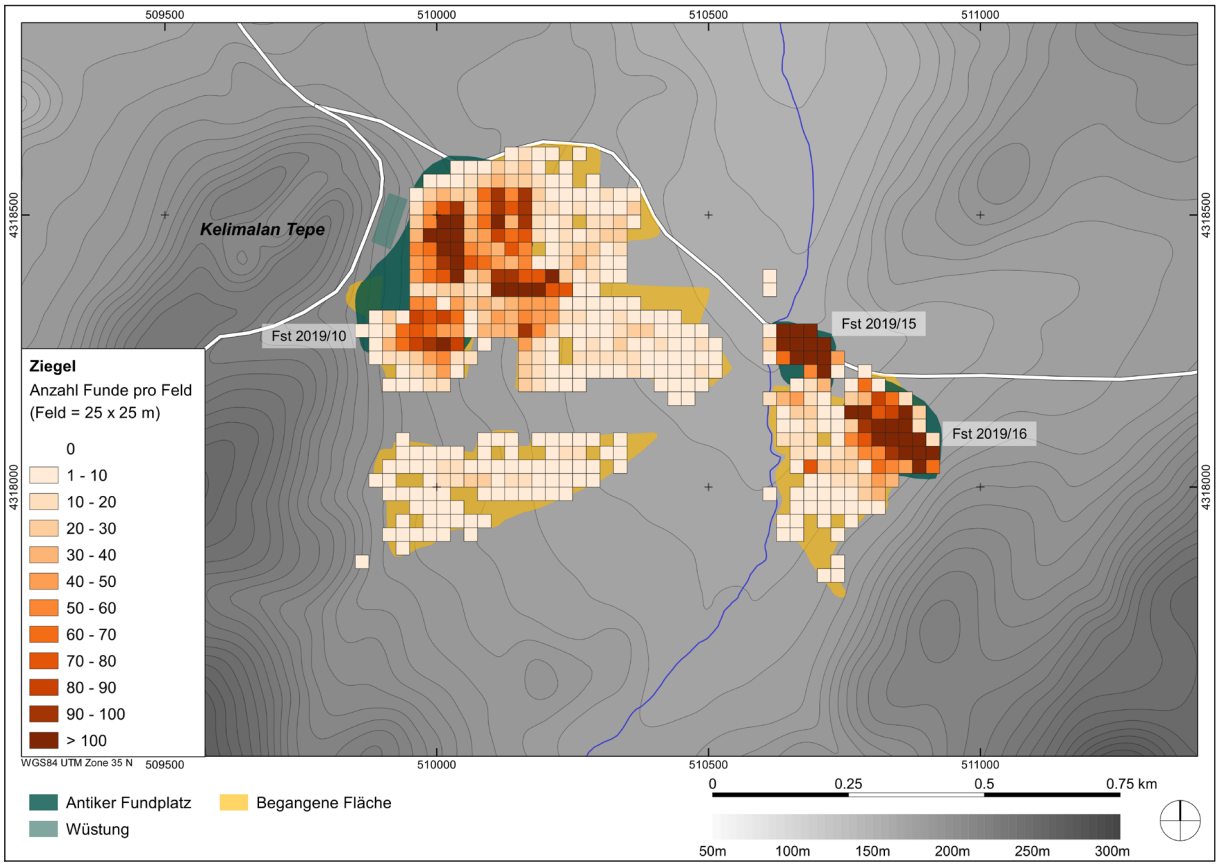

Abb. A3.10 Umland, Survey-Areal B. Kartierung aller Ziegelfunde

Fundstelle 2019/07 – Kaiserzeitliche Villa mit Produktionsstätte (?)

Bei Feldbegehungen im Jahr 2011 wurden auf einer Fundstelle (ST 100) ca. 1,7 km nordwestlich von Bozköy sehr viel Fundmaterial sowie auffällig viele Marmorbruchstücke festgestellt[767]. Die Fundstelle liegt auf einem nach Norden hin leicht abfallenden Hang, der heute als Olivenhain genutzt wird, mit Blick auf die Ebene und bis nach Pergamon (Abb. A3.1). Eine intensive Begehung und geophysikalische Prospektionen brachten in diesem Jahr neue Erkenntnisse zur Ausdehnung, Gestalt und Funktion des Platzes, der heute als Olivengarten genutzt wird.

Das Fundmaterial zieht sich auf einer Breite von rund 200 m den Hang etwa 300 m hinab, wobei im nördlichen Bereich, der in die Ebene übergeht, deutlich dichtere Konzentrationen festgestellt wurden. Insgesamt fand sich auf der gesamten Fläche sehr viel gut erhaltenes Fundmaterial. Dabei handelt es sich neben wenig späthellenistischer Keramik überwiegend um Feinkeramik, die in den Zeitraum vom 1.–7. Jh. n. Chr. datiert. Erwähnenswert sind in diesem Zusammenhang auch zahlreiche Fehlbrände von Ziegeln, Tonrohren und Amphoren, die zusammen mit Tonschlacken deutliche Hinweise auf eine keramische Produktionsstätte liefern.

Gleichzeitig wurden mehrere unvollständige, teilweise kannelierte Säulentrommeln aus Marmor festgestellt. Unter den gefundenen Marmorbruchstücken befanden sich zudem Wand- bzw. Bodenplatten aus grünem Marmor. Einen Hinweis auf repräsentative Großarchitektur aus Marmor brachte der Fund eines Giebelfragments mit den beachtlichen Maßen 120 cm × 90 cm × 55cm. Dieses Stück wurde in das Steindepot des Museums Bergama in der Roten Halle transportiert.

Oberirdisch sichtbar und heute als Terrassierungsmauer genutzt ist ein mindestens 16 m langes Gebäude aus Opus caementicium mit den Ansätzen verschiedener Räume oder Kammern. Weitere große Einzelgebäude zeigen sich in den ersten geophysikalischen Messungen (Abb. A3.11). In der Geomagnetik lassen sich bereits die Standorte mehrerer Gebäude identifizieren. In der Kombination mit geoelektrischen Messungen lassen sich auch die Umrisse der Gebäude erfassen sowie deren Erhaltungstiefen feststellen. Aufgrund der vielversprechenden Ergebnisse soll der Fundplatz in den kommenden Kampagnen möglichst vollständig erfasst werden.

Die Ergebnisse dieser Kampagne weisen auf einen kaiserzeitlichen Landsitz aus mehreren großen Einzelgebäuden und mit aufwendiger marmorner Repräsentationsarchitektur in bester Lage mit Blick in die Ebene und auf den Stadtberg von Pergamon hin. Gleichzeitig kann man eine daran angeschlossene Produktionsstätte für keramische Güter annehmen.

767 Pirson 2012b, 217 (M. Zimmermann).

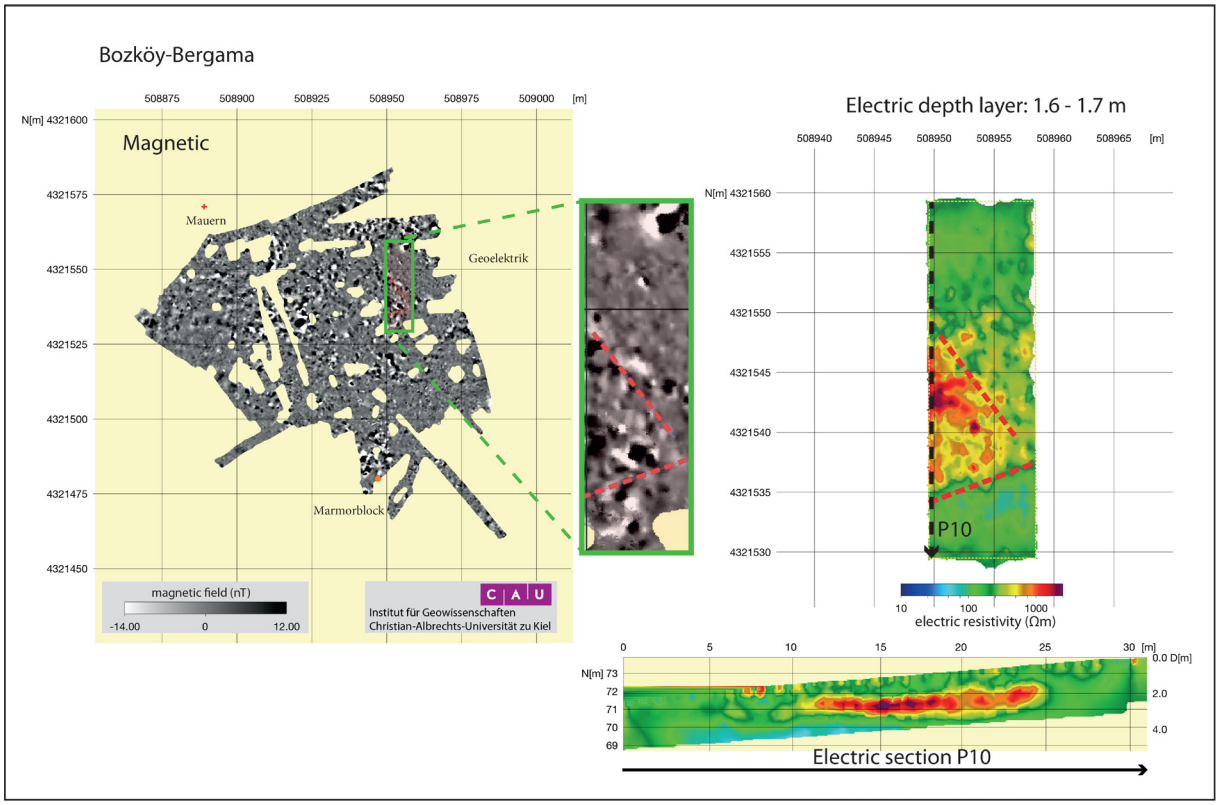

Abb. A3.11 Umland, Fundstelle 2019/07. Links: Geomagnetik; rechts: Geoelektrik

Fundstelle 2019/12 – Römische Brücke

Bislang war nur bekannt, dass sich unmittelbar südlich des Eğrigöl Tepe (Halisarna) die Überreste einer römischen Brücke über den Bakırçay (Kaikos) befanden[768]. Ihre genaue Position ließ sich jedoch nicht mehr ermitteln.

Während der diesjährigen Geländearbeiten wurde das Flussbett im Bereich des Eğrigöl Tepe vertieft und begradigt. Im Zuge dessen wurden auch die Uferböschungen so stark abgebaggert, dass die Überreste der Brückenköpfe sowie eines möglichen Pfeilers im Flussbett zutage traten. Zwar wurden die Überreste bei den Baggerarbeiten stark in Mitleidenschaft gezogen, doch konnten wir zumindest die genaue Position festhalten und den aktuellen Zustand fotografisch dokumentieren.

Sonstige Fundplätze

Auf dem so genannten Harita Tepe (Fundstelle 2019/11) 1,3 km nordwestlich von Bozköy befindet sich ein osmanischer Friedhof. Über das Plateau mit Blick in das westliche untere Bakırçay-Tal liegen zahlreiche fragmentierte Bauglieder aus Andesit und Marmor verstreut, die vermutlich als Grabsteine an diesem Platz wiederverwendet wurden. Die Frage nach der Herkunft der Spolien bleibt unbeantwortet. Eine mögliche Quelle könnte aber die nahe gelegene Fundstelle 2019/07 nördlich von Bozköy sein.

B. Ludwig

768 Diest 1889, 30; Philippson 1910, 78; Conze 1912, 116–117 (C. Schuchhardt); Pirson 2012b, 215 (M. Zimmermann).

Site 2019/05 – Location and Geographical Situation

The site lies 1.4 km southeast of Süleymanlı, west of Bergama. Kalarga Tepe, ancient Teuthrania, is located 1.4 km southwest of the site (Abb. A3.1). The terrain on which the site extends is slightly elevated and therefore located on dry land. To the east of the site, an old river arm *(azmak)* forms a natural border, while to the west, the old road between Bergama and Çandarlı (Pergamon-Pitane) is situated. These features provide a suitable place for the location of the site in the middle of Bakırçay (Kaikos) plain.

At present, the site extends over four different fields and covers an area of roughly 175 m × 100 m. During the survey in 2019, a pomegranate garden was located at the southwestern part and a cornfield at the south. The largest field is at the north of the site, while the fourth field is situated to the south.

The site was discovered in a previous survey in 2009 (Teut 114) and geophysical prospections were carried out that year and in 2011 respectively[769]. Previous research at the site also included geoarchaeological exploration, leading to a first interdisciplinary interpretation of the site in the context of the development of the late Holocene landscape[770]. On this basis, three different options for the interpretation of the site and its dating were suggested: a sanctuary from the 2nd century CE, a rich estate or villa from the 4th–8th century CE, or a production area with lime kilns from late Antiquity or the Byzantine period. However, more detailed archaeological investigation has been suggested to go beyond hypothetical scenarios.

In order to make progress in this direction and to the territorial extent of the site, its chronology and its function, further geophysical prospections as well as intensive and extensive surveys were conducted. The freshly ploughed fields at the northern and southeastern part of the site offered an opportunity for better inspection. However, the pomegranate garden to the southwest and the cornfield adjacent to it restricted access to and observation of this particular area for the survey team.

Nonetheless, it was possible to carry out an intensive survey at the northern field, where a grid with 191 counting fields (1.5 m × 1.5 m) in a 10 m distance from each other was established. In each counting field, brick and pottery pieces were recorded statistically (Abb. A3.12, A3.13). Furthermore, the recently ploughed southernmost field was examined with an extensive survey. Of the numerous bricks found at the northern part of this field, some were preserved almost completely. While some of them showed burn marks, others were observed to be burnt to slag, indicating that they were probably exposed to a severe fire.

As in previous surveys, numerous stones including marble fragments were recorded in and around the site during the survey in 2019. These stones were probably exposed after the fields have been ploughed. Along with marble fragments, carved blocks, pithos fragments, bricks, slags and burnt material recorded in two stone piles, a marble entablature fragment with geisipodes, a fragment with a floral decoration and an andesite column were found on the northern field, which are of particular interest. The fact that no weathering traces were detected on the marble entablature fragment and its rather short height could indicate that it may have belonged to interior architecture (Abb. A3.14). Some of the pieces were transported to the stone depot of the Museum of Bergama in the Red Hall.

769 Pirson 2010, 178–180 Fig. 45 (M. Zimmermann); Pirson 2012b, 216 Fig. 49 (M. Zimmermann).

770 Schneider et al. 2015.

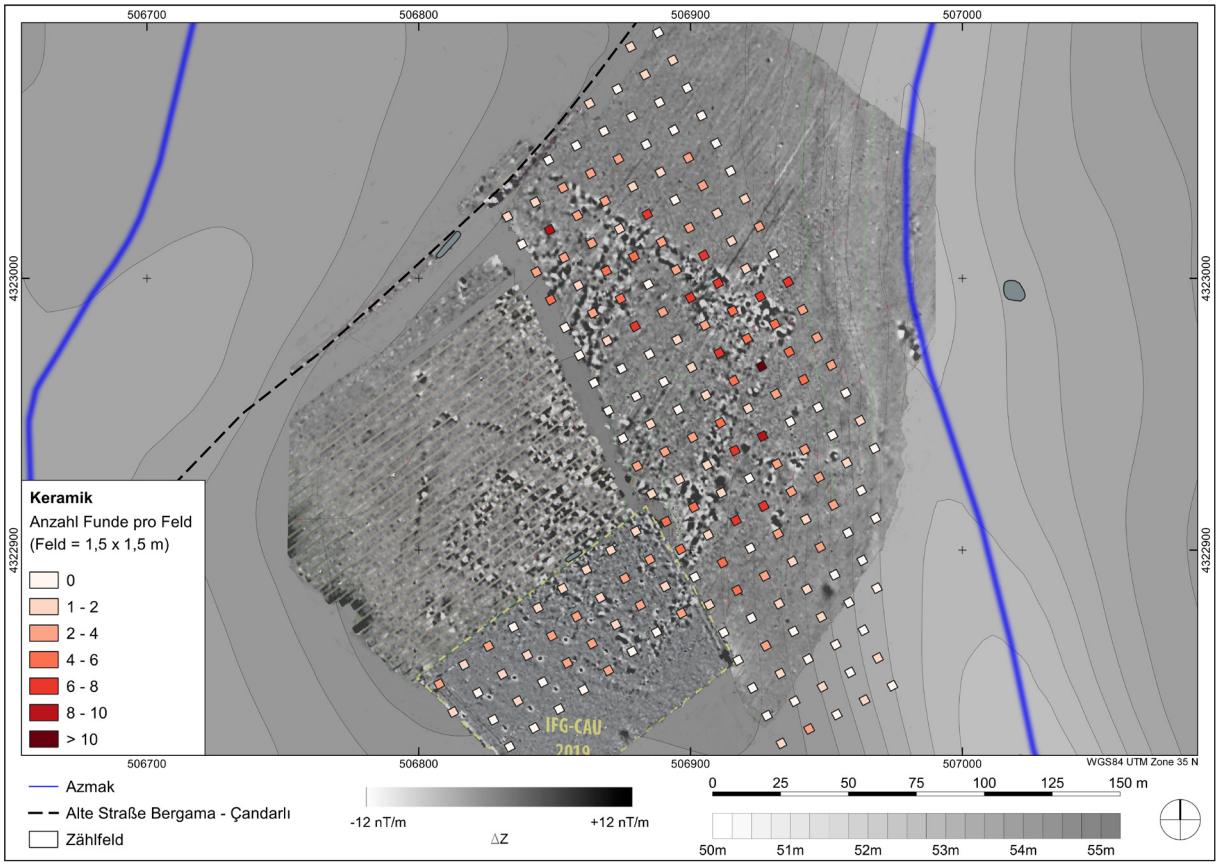

Abb. A3.12 Umland, Site 2019/05. Mapping of all pottery finds with geomagnetics

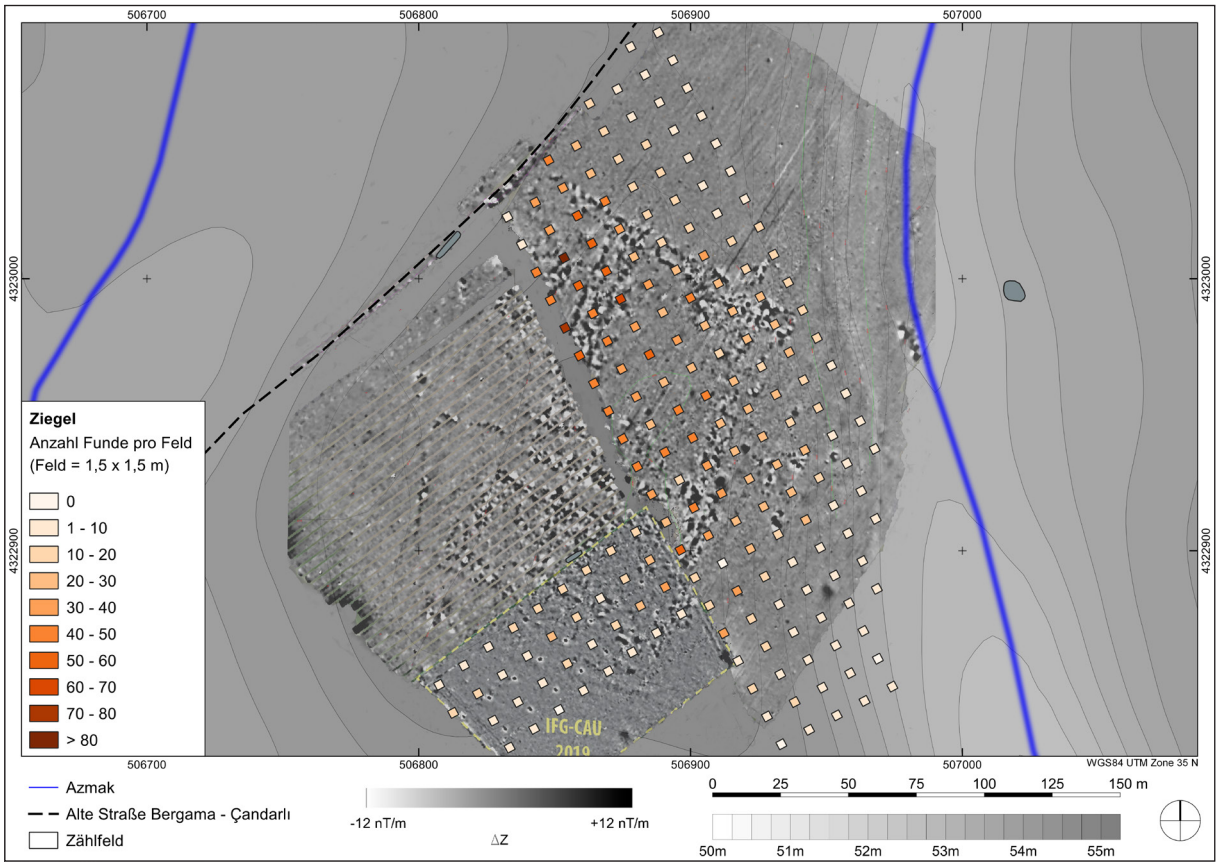

Abb. A3.13 Umland, Site 2019/05. Mapping of all brick finds with geomagnetics

The results of the survey are in accordance with the measurements of the geophysical prospections. The intensive survey of the northern field and the extensive survey conducted at the southernmost field revealed the extent of the site. While the distribution of potsherds goes far beyond the slightly elevated centre of the site (Abb. A3.12), the concentration of brick pieces corresponds with the layout of the building structure observed in the geomagnetic prospections (Abb. A3.13). As for the dating of the pottery, fragments from the Hellenistic, Roman Imperial, Late Antique, Byzantine and Ottoman periods demonstrate that the site was used over a long time-span.

Abb. A3.14 Umland, Site 2019/05. Marble fragment that was probably part of the interior design of the building complex

Geomagnetic prospections conducted at the southeastern part of the site enabled the completion of the geophysical measurements. The results may be interpreted as a rectangular building structure in approximately northeast-southwest orientation. Architectural remains at the northern, western and southern parts are somewhat denser and give a better understanding of the structure, while the eastern and southeastern sides are less clear. As it has been pointed out before, the general scheme of the geomagnetic prospections gives the impression of a large building surrounded by smaller structures with parallel walls, which may be tentatively interpreted as stoai. These smaller structures are especially observable at the northern, western and perhaps southern parts of the building. According to the geomagnetic prospection, those on the northern part show dimensions of approximately 5 m × 5 m.

It is difficult to determine the exact function of the architectural complex as reflected in the geophysical mapping and the surface finds. It may be the product of various building-phases, and functions might have changed over time. Already suggested functions such as a sanctuary or an estate remain plausible interpretations. A more systematic evaluation of both the finds and the geophysical prospection will hopefully lead to a well-founded final assessment – as far as this is possible at all on the basis of survey findings. Such an assessment has to take into account once again the prominent location of the site next to the ancient road leading from Pergamon to Pitane and in the vicinity of Teuthrania (Kalarga Tepe). Further elements of the man-made environment in the central western Bakırçay plain have been revealed by the survey in 2019:

Site 2019/08 – The site is located immediately southeast of the probable burial mound (2019/06) at the eastern skirts of Sultantepe (see below). According to the information obtained from a local farmer, large quantities of mussels or snails as well as spindle whorls were recovered during agricultural activities in the fields. Although they were not observed during our survey, the abundant existence of snails or mussels is noteworthy. Snails might have been used to dye fabrics, but whether they have a connection to site 2019/06 is unknown for now. Fortunately, one of the spindle whorls was recovered and preliminary observations indicate a prehistoric date.

B. Ludwig, Z. M. Aksan

Abb. A3.15 Umland, Site 2019/06. Probable tumulus shown in red circle and Sultantepe to the west. Ancient Teuthrania (Kalarga Tepe) in the background to the left

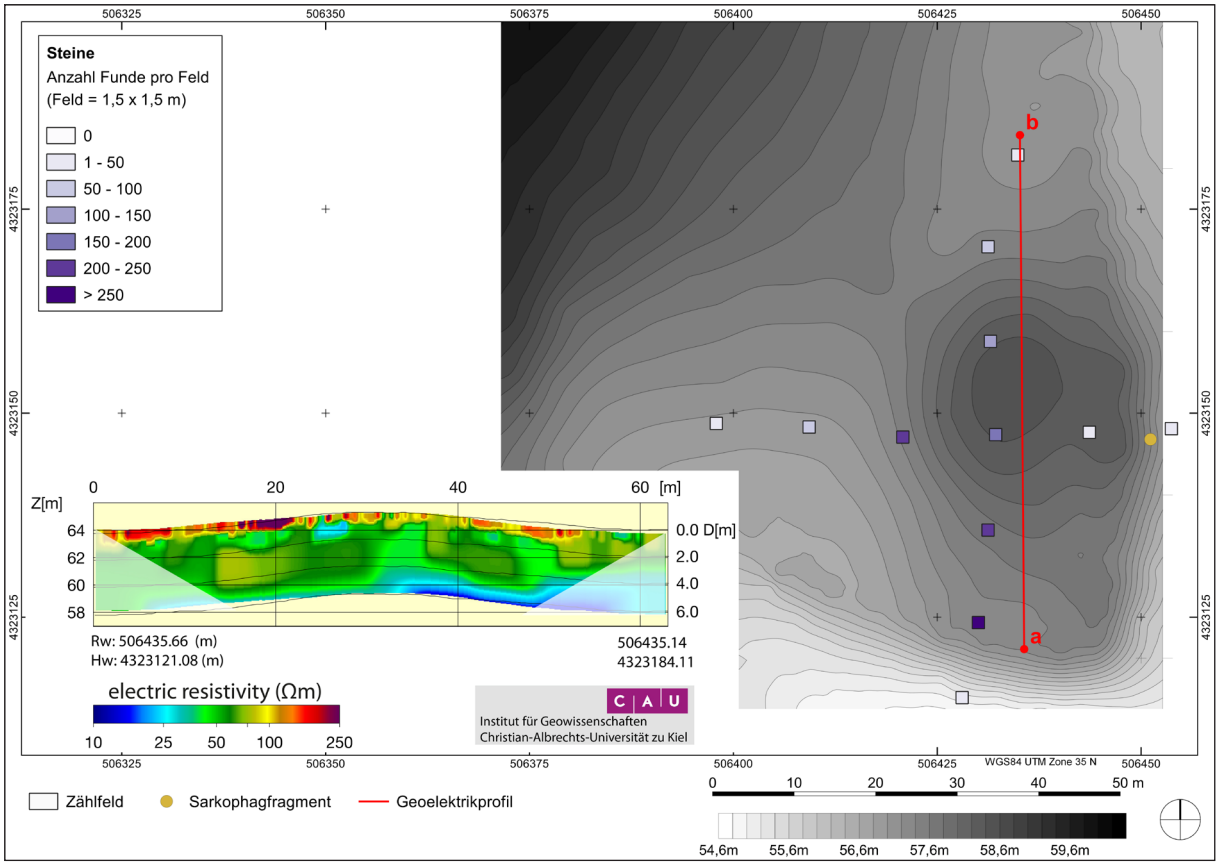

Abb. A3.16 Umland, Site 2019/06. Topographical map showing the boundaries of the mound and its location at the eastern skirts of Sultantepe. Distribution of river pebbles in the counting fields and position of the geoelectric profile

Site 2019/06 – Gravemound and Necropolis(?)

A small hill was spotted during the field walks conducted west of the building complex (Site 2019/05) near Süleymanlı village[771]. At first sight, the hill seemed to be a natural formation due to the olive grove on top of it. However, after some further observations and investigations, it was recognised as a probable tumulus.

The mound lies approximately 500 m southeast of Süleymanlı village, west of Bergama (Abb. A3.1). It is situated on a sloping hillside, on the eastern skirts of a natural hill called Sultantepe. The olive grove on top of the mound continues northwards and westwards towards Sultantepe (Abb. A3.15). The building complex surveyed as Site 2019/05 (see above) is in close vicinity, approximately 500 m southeast of the mound, while the old road between Çandarlı and Bergama is also nearby.

The mound is situated within in the boundaries of three different agricultural fields. It is severely damaged and flattened due to ploughing and other cultivation activities. The soil on top of the mound was observed to be mixed with stones (mostly river pebbles) in varying dimensions, ranging from 3,0 cm to 15 cm, and also partially sand. Its colour changed from grey to brown. Soil formation consisting of river pebbles in different sizes has already been observed at the tumulus Yığma Tepe at Pergamon[772]. It is noteworthy that the same soil formation could not be detected on the adjacent fields surrounding the mound. In order to compare and demonstrate the number of stones in the soil formation on the mound and the fields, two transects with a total of 12 counting fields were placed on the site and all stones measuring more than 3,0 cm in dimension were counted in each counting field (Abb. A3.16). The result clearly demonstrated that a certain amount of river pebble was accumulated on the hilltop, which cannot be explained as being natural.

The site was recorded with a DGPS to map the mound and to determine its boundaries (Abb. A3.16). Although it was difficult to establish the exact dimensions of the mound due to damage, an approximate measure of 60 m × 50 m may be given, while the preserved height may be measured to approximately 2 m. Moreover, a geoelectric profile of 64 m was placed over the site (Abb. A3.16). It shows some potentially significant anomalies, but further prospections are needed before any conclusions can be drawn.

Stones in varying dimensions had been extracted and placed on the eastern and southern edge of the mound by the owners of the fields adjacent to the site. Among these stones, a fragment of a sarcophagus lid was found on the eastern part of the mound. According to local informants, there had been numerous stones indicating the recovery of graves in the direct vicinity in the past years. Therefore, the area has been known as a historical burial ground by local people. In this context it is remarkable that present-day graveyard of Süleymanlı village is actually very close to the mound, approximately 400 m to the west, at the southwestern skirts of Sultantepe.

It is crucial to examine the possible connections of the probable tumulus with the surrounding sites. The proximity of the burial mound to the building complex (Site 2019/05) and to the old road has already been mentioned. The close proximity of the mound to ancient Teuthrania and its placement on the axis (NE-SE) between Teuthrania and Pergamon indicates its potential significance, too.

Z. M. Aksan

771 A visit was paid to the mentioned area due to the information given by the local farmers, who stated that ancient grave stones were found in that specific area.

772 Pirson 2016, 161–164.

Zusammenfassung und Überblick

Die erste Feldkampagne des neuen Umlandsurveys im Rahmen von TransPergMikro war in mehrfacher Hinsicht ein vielversprechender Auftakt. Die nochmals verbesserte und nun nahezu vollständig computerbasierte Dokumentationsmethode hat sich als effizient und leicht zu erlernen bewährt. Die Arbeit in relativ großen deutschtürkischen Teams hat über Sprachbarrieren hinweg sehr gut funktioniert. Wesentlich dazu beigetragen hat das Engagement mehrerer Dozentinnen und Dozenten türkischer Universitäten, von denen die Studierenden in kleinen Sub-Teams vor Ort angeleitet und betreut wurden[773]. Umfang und Vielfalt der neu erzielten Ergebnisse unterstreichen einerseits das große Potential des Untersuchungsgebiets für die Erforschung ländlicher Siedlungsstrukturen und antiker Landnutzung. Andererseits machen sie auch deutlich, dass wir mit dem Verständnis der komplexen Befunde im Einzelnen und in den größeren Zusammenhängen der Mikroregion noch am Anfang stehen. Insofern können die folgenden Überlegungen nur vorläufiger Natur sein und sollen als erste Arbeitshypothesen beim Fortgang der Untersuchungen dienen.

Die ländliche Siedlung am Kuyulu Kaya (Fst 2019/2) im Tekkedere-Tal steht für eine bemerkenswerte Siedlungskontinuität von der Bronzezeit bis in die spätbyzantinische Epoche, d. h. etwa über den gleichen Zeitraum, in dem auch der Stadtberg von Pergamon besiedelt war[774]. Diese Ortsfestigkeit – sofern anhand oberflächlicher Keramikfunde zu beurteilen – verlangt nach Erklärungen, zumal sich im Tekkedere-Tal auch bemerkenswerte Dynamiken beobachten lassen (Abb. A3.3, A3.4, A3.6): Nachdem der Kuyulu Kaya als Siedlungsplatz aufgegeben worden war, wechselte die Ansiedlung im Tal bis heute noch vier Mal ihren Ort und bewegte sich dabei kontinuierlich von Ost nach West bis zum östlichen Rand der Ebene des Bakırçay mit den Hauptverkehrswegen. Ein bis zwei weitere, sehr kleine Ansiedlungen (2019/4 und 2019/13) hatten höchstens vom Hellenismus bis in die frühe Kaiserzeit hinein Bestand, d. h. sie existierten parallel zum Kuyulu Kaya und wurden dann aufgegeben. Dies entspricht der Situation, die wir bereits von mehreren kleinen ländlichen Fundplätzen in der Umgebung von Elaia kennen, wo mit dem Ende des Hellenismus offenbar auch die Zahl ländlicher Siedlungsplätze zurückging[775].

Lange Kontinuitäten in der Besiedlung legt auch das Fundmaterial an anderen Plätzen nahe (Abb. A3.1): Im Bereich des Gebäudekomplexes bei Süleymanlı 2019/5 sind Scherben hellenistischer bis osmanischer Zeit aufgelesen worden. Die vermutete Villenanlage bei Bozköy 2019/7 hat Keramik vom späten Hellenismus bis in das 7. Jh. n. Chr. erbracht und im intramontanen Becken bei Çalıbahçe reicht das chronologische Spektrum zumindest eines Fundplatzes (2019/15) von der Klassik bis in die Spätantike. Signifikante Brüche in der ländlichen Besiedlung sind innerhalb des Untersuchungszeitraums vom 3. Jh. v. Chr. bis 3. Jh. n. Chr. bislang hingegen nicht zu verzeichnen.

Betrachtet man die untersuchten Plätze unter dem Aspekt der Transformation, so fällt ins Auge, dass die großen Anlagen bei Süleymanlı und Bozköy nach Anfängen oder Vorläufern in hellenistischer bzw. späthellenistischer Zeit vor allem in der römischen Kaiserzeit eine Blüte erleben, die sich auch

773 Zeki Mete Aksan (Sinop), Sarp Alatepeli (Izmir), Gözde Şakar (Manisa), Murat Tozan (Izmir).

774 Für den aktuellen Forschungsstand zur Siedlungsgeschichte Pergamons und seiner Mikroregion, auf den im Folgenden verwiesen wird, s. Pirson 2017, bes. 92–96 (Siedlungskonzentration im 1. Jh. v. Chr.) und 112–113 (kaiserzeitliche Villen und andere *otium*-Elemente).

775 Pirson et al. 2015, 35.

in der reichen architektonischen Ausstattung niederschlägt. Ähnliches gilt für Fundplatz 2019/10 im Çalıbahçe-Becken, der sich durch die Verbindung von Indizien für aufwendige landwirtschaftliche Produktionseinrichtungen mit einer gehobenen Ausstattung auszeichnet. Die Keramik legt eine Nutzungsdauer vom 1.–3. Jh. n. Chr. nahe, während im Umfeld des Platzes vor allem späthellenistisches Material angetroffen wurde.

Die Chronologie der von uns im Jahr 2019 untersuchten Plätze scheint die Bedeutung des 1. Jhs. v. Chr. und der anschließenden römischen Kaiserzeit für die Transformation der Mikroregion zu unterstreichen. Dies betrifft sowohl Hinweise auf einen zahlenmäßigen Rückgang kleiner ländlicher Einheiten als auch die Entstehung bzw. den Ausbau aufwendiger Villenkomplexe, wie sie für Kleinasien eigentlich untypisch sind[776]. Beim aktuellen Stand der Forschung dürfen freilich noch keine Generalisierungen vorgenommen werden; erst die Zusammenführung der Ergebnisse aus den verschiedenen Teillandschaften der Mikroregion kann ein belastbares Bild ergeben.

Gleiches gilt für erste Überlegungen zur Hierarchie der Siedlungsplätze. Ähnlich wie in der Stadt, so gab es auch in der Landschaft favorisierte Lagen, bei deren Auswahl wirtschaftliche Kriterien zwar eine wichtige, nicht jedoch exklusive Rolle spielten (Abb. A3.1). So fällt ins Auge, dass die Siedlungen im engen und steilen Tal des Tekkedere – das bis heute wie eine eigene, abgeschlossene Welt anmutet – in Hinblick auf Größe und architektonische Ausstattung im Vergleich zu Plätzen wie bei Süleymanli, Bozköy oder einer weiteren, noch nicht näher untersuchten Fundstelle (2019/3) am Rand der Kaikos-Ebene südwestlich des Tekkedere-Tals erheblich abfallen. Neben dem Zugang zu ausgedehnten agrarischen Nutzflächen in den erhöhten Randzonen der Ebene (Süleymanlı) oder an den sanft auslaufenden Hängen des Yunt Dağı (Bozköy, Fundstelle 2019/3)[777], waren offenbar auch die Nähe zu den Hauptverkehrswegen und damit verbunden die Präsenz der Plätze in der Wahrnehmung der Zeitgenossen sowie ihre Sichtbeziehungen zu prominenten Orten der Mikroregion wie Pergamon oder Teuthrania von Bedeutung. Der Rang einzelner Ortslagen dürfte neben ihrem wirtschaftlichen Potential und ihrer verkehrstechnischen Anbindung also auch von ihrer Position innerhalb der visuellen Region Pergamons bestimmt gewesen sein[778]. Ein solcher Zusammenhang ist von besonderem Interesse, da die visuelle Region bislang in erster Linie als Phänomen der hellenistischen Epoche fassbar ist.

Innerhalb der Hierarchie, die sich hier in ersten Grundzügen abzeichnet, würden Plätze wie Fundstelle 2019/10 im Çalıbahçe-Becken eine Zwischenstellung einnehmen (Abb. A3.1, A3.9, A3.10). Sie hatte Zugang zu größeren agrarischen Flächen als im Tekkedere-Tal[779] und die geomorphologische Situation des Beckens ist zudem offener und weitläufiger. Für den Platz ist eine leicht erhöhte und damit dominante Position am östlichen Abhang des Keliman Tepe gewählt worden, die zugleich den unmittelbaren Zugang zu den agrarischen Flächen ermöglicht. Dementsprechend zeugt Fundstelle 2019/10 von agrarischer Produktion auf gehobenem technischem Niveau verbunden mit repräsentativen Ansprüchen im Wohnen und übertrifft darin die anderen von uns nachgewiesenen Fundstellen im Çalıbahçe-Becken.

776 Hütteroth – Höhfeld 2002, 126–127.

777 Zur Fruchtbarkeit der Ebene des Kaikos nach dem Zeugnis antiker Schriftquellen s. Sommerey 2008, 159–160.

778 Zur visuellen Region Pergamons s. Williamson 2016; Pirson – Ludwig (in press).

779 Siehe Pirson 2020, § 139.

Schließlich werfen die eindrucksvolle Größe des vermuteten Villenkomplexes bei Bozköy (Abb. A3.11) und seine unerwartet reiche architektonische Ausstattung Fragen nach den Akteuren im ländlichen Raum und ihren wirtschaftlichen Grundlagen auf. Martin Zimmermann hat vorgeschlagen, Anlagen wie bei Bozköy als „ländliche Anwesen der pergamenischen Aristokratie der hohen Kaiserzeit" zu interpretieren[780]. Zuvor hatte bereits Helmut Halfmann einen Angehörigen der senatorischen Aristokratie Pergamons als Inhaber einer *villa marittima* westlich der Kane-Halbinsel vermutet, d. h. der gleichen Personengruppe, die in trajanisch-hadrianischer Zeit das Bauprogramm in Pergamon finanzierte[781]. Vor diesem Hintergrund ist der Nachweis der Produktion von Baukeramik sowie von Amphoren in der Villa bei Bozköy von größtem Interesse: Erstere gibt Hinweise auf die wirtschaftliche Involvierung der pergamenischen Eliten in das Bauwesen über ihre Rolle als Stifter hinaus, während die Herstellung von Amphoren am ehesten mit dem Verkauf und Transport eigener landwirtschaftlicher Produkte zusammenhängen dürfte[782]. Die geplanten intensiven geophysikalischen Prospektionen in Bozköy werden in diesem Punkt hoffentlich ebenso zu vertieften Einblicken führen wie die Untersuchung weiterer großer Landgüter im Verlauf von TransPergMikro.

F. Pirson

780 Siehe auch Sommerey 2008, 158; Pirson 2012b, 217 (M. Zimmermann).

781 Halfmann 2001, 54.

782 Zum Öl- und Weinanbau in der Mikroregion Pergamon nach dem Zeugnis der antiken Schriftquellen s. Sommerey 2008, 162–163 Zur Keramikherstellung in römischen Villen s. Marzano – Métraux 2018a.

A.4 Die Arbeiten des Umland-Surveys 2020

Published manuscript (own contribution 70 %):

B. Ludwig – F. Pirson, Die Arbeiten des Umland-Surveys 2020, in: F. Pirson, Pergamon – Bericht über die Arbeiten in der Kampagne 2020, Archäologischer Anzeiger 2021/2, 258–268

DOI: https://doi.org/10.34780/ayd6-y4fa

Das im Jahr 2019 begonnene Programm des archäologischen Umlandsurveys wurde in diesem Jahr mit einem Schwerpunkt auf dem Geyikli-Tal im Kozak-Gebirge nordöstlich von Dikili fortgesetzt (Abb. A4.1)[783]. Als Anknüpfungspunkt für die Geländearbeiten dienten hier die Überreste einer Thermenanlage am Fluss Geyikli südlich von Kıroba-Mazılı, deren Umgebung das Survey-Areal C-1 (40,8 ha) bildete[784]. Survey-Areal C-2 (67,3 ha) befand sich wenige Kilometer nordöstlich auf der Kavalan-Hochebene oberhalb der Wüstung von Eski Mazılı. Die diesjährigen Arbeiten umfassten weiterhin die Umgebung des bereits 2019 untersuchten mutmaßlichen Landsitzes aus der römischen Kaiserzeit nördlich von Bozköy und einen neu entdeckten antiken Gebäudekomplex am Stadtrand von Bergama. Erste Ergebnisse zur Untersuchung einer Höhle ca. 5 km nordwestlich von Kıroba-Mazılı, die Befunde aus dem Epipaläolithikum aufweist und später als Kybele-Heiligtum genutzt wurde, werden weiter unten in einem eigenen Beitrag vorgestellt. Die geplanten geophysikalischen Prospektionen mussten wegen der Corona-Pandemie auf 2021 verschoben werden.

Antike Siedlungsspuren im Geyikli-Tal bei Kıroba-Mazılı (Survey-Areal C-1)

Nordöstlich von Dikili mündet das Geyikli-Tal von den Ausläufern des Kozak-Gebirges kommend in die Bakırçay-Ebene. Der gleichnamige Fluss Geyikli (früher auch Arpalık) durchfließt das Tal und mündet bei Elaia als Sarıazmak in den Bakırçay. Von der Ebene getrennt wird das Geyikli-Tal durch den Berg Geyikli Dağ (Abb. A4.1).

Bei Kıroba-Mazılı öffnet sich das ansonsten sehr enge Tal und ist auf etwa 1 km Länge rund 1 km breit (Abb. A4.2, A4.3). Das Gelände fällt nach Süden bis zum Fluss ab und wurde als Survey-Areal C-1 intensiv begangen[785]. Dabei gelang die Feststellung mehrerer neuer Fundplätze, die möglicherweise mit einer Thermenanlage (Fundstelle 2020/02) und einem unterirdischen Zisternenraum (Fundstelle

783 Die Arbeiten sind Bestandteil des Langfristvorhabens TransPergMikro, das von der Deutschen Forschungsgemeinschaft gefördert wird. Leitung des Teilprojektes ‚Archäologischer Survey der Mikroregion Pergamon' der Klassischen Archäologie durch Verfasser und G. Ateş (CBÜ Manisa), örtliche Leitung durch B. Ludwig (DAI Istanbul). Die Arbeiten dauerten vom 31.08.–06.10.2020.

784 Die Thermenanlage und ihre Umgebung sind erstmalig 2009 durch ein Team unter Leitung von M. Zimmermann (LMU München) begangen worden: Pirson 2010, 175 (M. Zimmermann). Das dort vorläufig als ‚römisch' angesprochene Aquädukt gehört wohl eher in osmanische Zeit. Die Ruinen der Thermen sind in Conze 1912, Taf. 1 verzeichnet, werden im Textteil aber nicht weiter erwähnt.

785 Zur Surveymethodik, siehe Pirson 2020, 206–207 (B. Ludwig – Z. M. Aksan – F. Pirson).

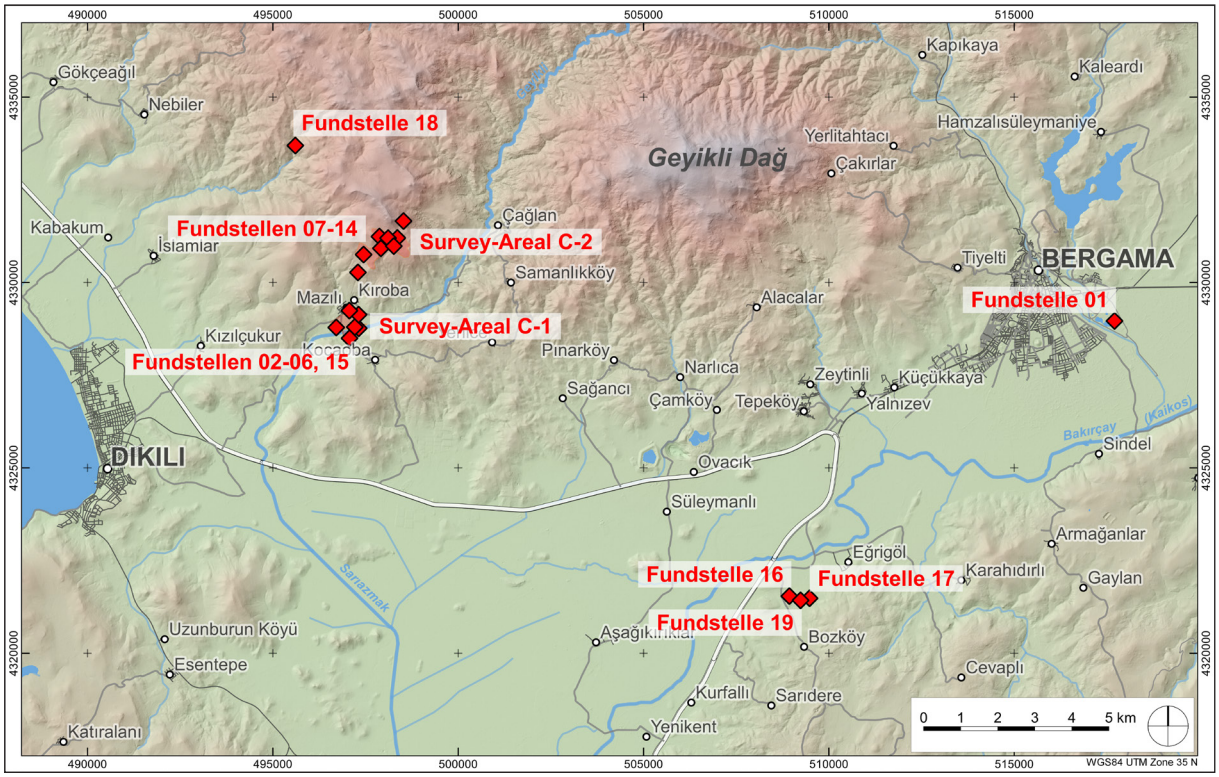

Abb. A4.1 Umland, Westliches unteres Kaikostal mit Ausläufern des Kozak-Gebirges und Geyikli Dağ. Übersicht über die Fundstellen und Survey-Areale der Kampagne 2020

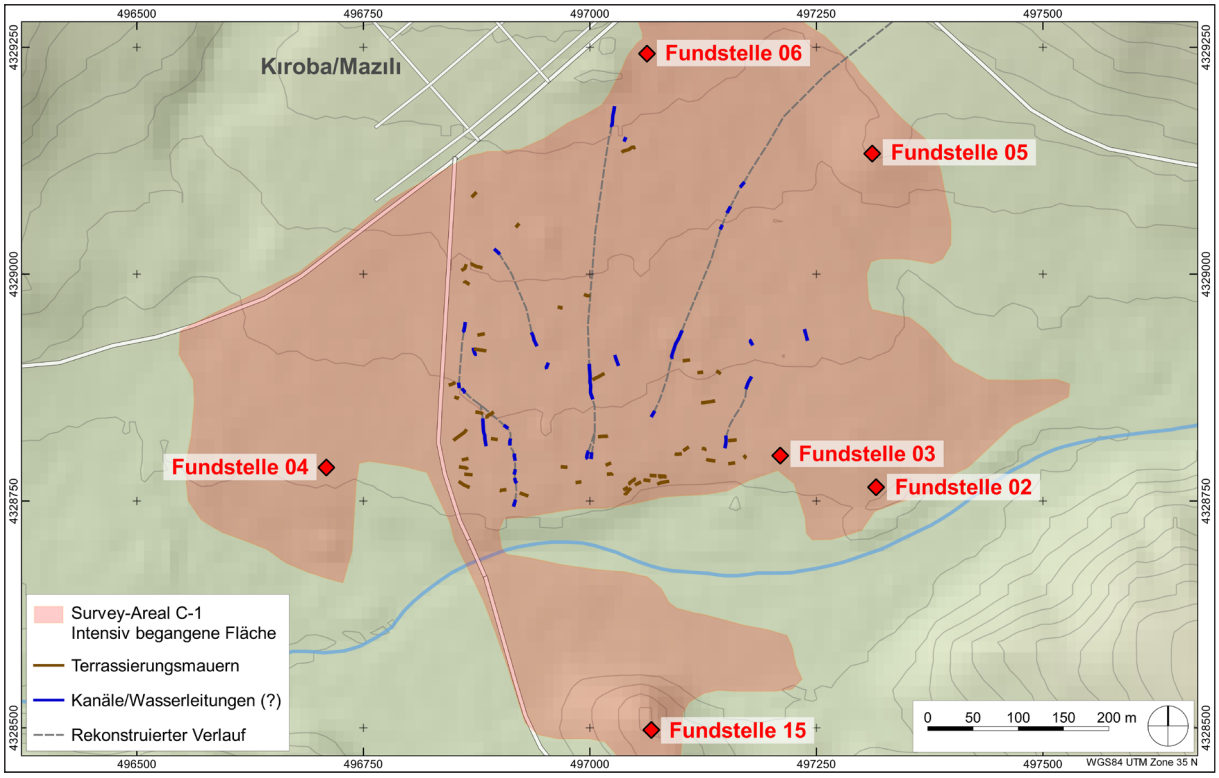

Abb. A4.2 Umland, Geyikli-Tal. Survey-Areal C-1 mit der Lage der Fundstellen und den dokumentierten Befunden

2020/03) am Geyikli-Fluss in der Nähe einer Thermalquelle in Verbindung stehen. Im Südwesten des Survey-Areals befinden sich mehrere Tumuli (Fundstelle 2020/04), die sich nur noch als leichte Erhebungen im Gelände abzeichnen. Weiterhin sind die Überreste eines Gebäudes jeweils am südlichen Dorfrand von Kıroba-Mazılı (Fundstelle 2020/06) sowie auf einem nahegelegenen Hügel (Fundstelle 2020/05) festgestellt worden. Lediglich am südlichen Dorfrand konnte neben Reibsteinen, Säulenbasen und -schäften auch Keramik aufgelesen werden, die vom Hellenismus bis in die römische Kaiserzeit datiert wird[786].

Dies liegt innerhalb des zeitlichen Spektrums der Keramik, die bei der Begehung des gesamten Survey-Areals aufgesammelt wurde und Siedlungsaktivitäten vom Hellenismus bis in die osmanische Zeit bezeugt. Eine Besonderheit stellt in dieser Hinsicht der Ilıca Tepe (Fundstelle 2020/15) dar, ein Hügel am südlichen Ufer des Geyikli. Das von sehr steilen Abhängen umgebene Gipfelplateau ist nur rund 10 m × 7 m groß und nach Süden über einen 30 m langen und 10 m breiten Sattel mit den Hängen des Geyikli Dağ verbunden. Es konnten zwar keine architektonischen Überreste mehr festgestellt werden, aber die Keramik belegt eine Nutzung des Platzes in der Bronzezeit, der klassischen sowie hellenistischen Epoche. Aufgrund der Lage des Hügels an einem Übergang vom Geyikli-Tal in die Bakırçay-Ebene kann man davon ausgehen, dass der Ort auch aus strategischen Gründen als Siedlungsort gewählt wurde.

Weiterhin erwähnenswert sind die zahlreichen Mauern bzw. mauerähnlichen Strukturen, die überwiegend im südlichen Teil des Survey-Areals dokumentiert wurden (Abb. A4.2). Ein Teil der Befunde ist hangparallel orientiert und kann als einoder zweischalige Terrassierungsmauern interpretiert werden. Andere Strukturen verlaufen hingegen zum Teil über mehrere hundert Meter den Hang hinab bzw. hinauf und können daher eher mit dem Wassermanagement in Verbindung gebracht werden, zum Beispiel zur Bewässerung des offenen Talbereiches. Die Befunde sehen zunächst wie zweischalige Mauern aus, bilden jedoch Kanäle oder Einfassungen für Wasserrohre. Vergleichbare Strukturen befinden sich auf der Kavalan-Hochebene und führen noch heute Wasser zu modernen Viehtränken. Auch wenn eine Datierung bislang nicht möglich ist, liefern uns die Befunde zusammen mit den Terrassierungsmauern doch wichtige Informationen zur historischen Landnutzung im Geyikli-Tal.

Thermenanlage im Geyikli-Tal bei Kıroba-Mazılı (Survey-Areal C-1)

Rund 600 m südlich des Dorfes Kıroba-Mazılı am nördlichen Ufer des Geyikli liegen die obertägig sichtbaren Mauer- und Gewölbereste einer kaiserzeitlichen Thermenanlage (Fundstelle 2020/02). Wenige hundert Meter flussaufwärts entspringt eine heiße Thermalquelle[787] am südlichen Uferrand, die das Flusswasser im Bereich der Thermenanlage erhitzt und wohl einer der Hauptgründe für ihre Errichtung an diesem Platz war (Abb. A4.2, A4.3, A4.4). Bereits Pausanias berichtet von warmen Bädern in der Umgebung von Atarneus beim Ort Astyra, und es ist durchaus denkbar, dass er sich auf die hier beschriebenen Ruinen und den umgebenden Fundplatz bezieht[788].

In direkter Nähe und parallel zum heutigen Flussbett verläuft eine Mauer, deren Kern aus vermörtelten Andesitbruchsteinen besteht. Von den sorgfältig gearbeiteten Werksteinen der Schale haben sich nur

786 Vorläufige Datierung des Fundmaterials des Umlandsurveys 2021 durch G. Ateş (Manisa).

787 Jeckelmann 1996.

788 Paus. 4, 35, 10; Sommerey 2008, 148 mit Anm. 52.

Abb. A4.3 Umland, Geyikli-Tal. Gewölbereste der Thermenanlage (rot), heißes Thermalwasser im ausgetrockneten Flussbett (links). Weitere Mauern zwischen Fluss und Gewölberesten werden von der Ufervegetation verdeckt

Abb. A4.4 Umland, Geyikli-Tal. Gewölbereste der Thermenanlage

wenige erhalten. Die Mauer ist auf einer Länge von 22 m, einer Höhe von 1,8 m und einer Breite von 2,65 m erhalten. Sie weist außerdem drei Bögen mit einer Spannweite von mindestens 3,5 m auf, wovon der westliche jedoch bereits eingebrochen ist. Unklar ist, ob es sich um die flussseitige Außenmauer der Anlage handelt, denn Konstruktionsdetails am westlichen Ende der Mauer deuten auf eine Fortsetzung nach Süden hin. Die Reste gemauerter Bogenansätze zeigen weiterhin, dass sich das Gebäude auch nach Norden ausgedehnt haben muss. Östlich der Mauer fanden sich zahlreiche verstürzte Andesitquader, die unterschiedlichste Ab- und Einarbeitungen mit Konstruktionsdetails aufweisen. Direkt nördlich

an den Versturz schließt ein auf 5,5 m sichtbarer Mauerabschnitt mit einer etwa 1 m breiten Türdurchgangssituation an.

30 m weiter nördlich befindet sich eine künstliche Geländestufe aus der ein nach Süden hin offener und auf 14 m sichtbarer Gebäudeteil, bestehend aus drei Gewölben, herausragt (Abb. A4.4). Der westliche und östliche Bogen hat jeweils eine Spannweite von 2,5 m. Ihr Widerlager, die Kämpfer und Anfänger sind aus feingeglätteten großformatigen Andesitquadern gesetzt, wohingegen die Bögen und Gewölbe aus Bruchsteinen und Mörtel bestehen. Die nördlichen Bögen sind geschlossen und nur das mittlere Gewölbe mit einer Spannweite von 3 m ist nach Norden hin offen und weist damit auf eine Durchgangssituation hin.

Im südwestlichen Bereich des Fundplatzes soll sich ein marmornes Becken am Flussufer befunden haben. Lokale Zeitzeugen berichten, dass das Becken noch im 20. Jahrhundert zum Baden genutzt wurde, bevor es vor einigen Jahrzehnten bei einer winterlichen Flut oder einem Hangrutsch zerstört und verschüttet worden sein soll. Unebenheiten im heutigen Gelände weisen auf den vermuteten Standort des Beckens hin, es konnten aber bislang keine architektonischen Überreste festgestellt werden.

Die beschriebenen Befunde gehören zu einer mindestens 3000 m² großen Badeanlage mit Marmorausstattung, bestehend aus mehreren Einzelgebäuden und mit Zugang zu heißem Thermalwasser. Für weiteres Frischwasser sorgte möglicherweise ein unterirdischer Zisternenraum (Fundstelle 2020/03), der etwa 140 m nordöstlich der Anlage etwas hangaufwärts liegt (siehe unten). Das wenige Fundmaterial, das an der Oberfläche im Bereich der Therme aufgesammelt werden konnte, wird hauptsächlich in spätantike Zeit datiert und könnte durch neuzeitliche Bodeneingriffe für ein ehemaliges Gewächshaus inmitten der Fundstelle an die Oberfläche gelangt sein. Zur Datierung der architektonischen Befunde trägt es kaum bei. Von den für 2021 geplanten geophysikalischen Prospektionen erhoffen wir uns weitere Informationen zu Ausdehnung und Aufbau der Gesamtanlage.

Zisternenraum im Geyikli-Tal bei Kıroba-Mazılı (Survey-Areal C-1)

Etwa 140 m nordöstlich der Thermenanlage wurde ein unterirdischer Zisternenraum mit einem Zugangskorridor entdeckt (Fundstelle 2020/03). Aufgrund einer Raubgrabung gelangt man heute durch die aufgebrochene Decke eines Korridors in einen 4,0 m × 5,7 m großen und 3,5 m hohen Raum mit Tonnengewölbe (Abb. A4.2, A4.5). Die Bedeutung zahlreicher konstruktiver Details im Korridor- bzw. Zugangsbereich, wie zum Beispiel unterschiedlich ausgearbeitete Bodenbeläge, Baufugen in den Mauern oder eine mögliche Treppe, sind noch nicht abschließend geklärt worden. Außer diesem Zugang existiert noch eine Öffnung in der südlichen Gewölbewange, die einerseits Licht hineinlässt, andererseits aber wohl auch zum Schöpfen von Wasser diente. In die nördliche Gewölbewange mündet eine Tonrohrleitung in den Raum, die als Zuleitung für das Frischwasser interpretiert werden kann. In der südlichen Wand, zum Fluss hin, befinden sich wenige Zentimeter oberhalb des Bodenniveaus zwei Abläufe. In 2,1 m Höhe befindet sich oberhalb der Abläufe ein Bleirohr in der Wand, das als Überlauf diente. Oberhalb des maximalen Wasserstands, der heute von einer schwarzen Linie markiert wird, sind die Wände und Gewölbe mit einer 5 cm dicken, grauen Putzschicht verkleidet. Im unteren Bereich der Zisterne findet man einen 5 cm dicken hydraulischen Putz mit Ziegelzuschlag. Aus den Maßen des

Abb. A4.5 Umland, Geyikli-Tal. Überwölbter Zisternenraum mit Zugangssituation

Raumes und der Höhe des maximalen Füllstandes ergibt sich ein maximales Nutzvolumen von rund 48 m³ für diese Zisterne.

Obertägig wurden im Bereich der Zisterne mehrere massive Raubgrabungen festgestellt. Neben dem Zugang zur Zisterne wurde eine weitere, überwiegend aus Mörtel bestehende Struktur teilweise freigelegt, bei der es sich möglicherweise um ein weiteres Gewölbe handelt. Im Bereich der Thermenanlage und der Zisterne ist daher mit weiteren Gebäudestrukturen zu rechnen.

Inwieweit die obertägig aufgesammelte Keramik, die von der frühen Kaiserzeit bis in byzantinische Zeit reicht, die unterirdischen Bauwerke zeitlich einordnen kann, ist fraglich. Man darf jedoch annehmen, dass die Zisterne in Verbindung mit der wahrscheinlich in die römische Kaiserzeit zu datierenden Thermenanlage gestanden hat.

Antike Siedlungsspuren auf der Kavalan-Hochebene bei Eski Mazılı (Survey-Areal C-2)

2,7 km nordöstlich von Kıroba-Mazılı liegt mit dem Sarımsaklı (780 m) einer der höchsten Berge der Gegend. Etwas unterhalb des Gipfels dehnt sich die Kavalan-Hochebene von Südwesten nach Südosten aus. Die gesamte Hochebene sowie die Hänge bis zur Wüstung von Eski Mazılı wurden als Survey-Areal C-2 intensiv begangen (Abb. A4.6, A4.7). Die dabei entdeckten antiken Siedlungsspuren sind ein eindrücklicher Beleg für die Besiedlung und landwirtschaftliche Nutzung auch vermeintlich abgelegener Hochebenen.

Die Dorfwüstung von Eski Mazılı (Fundstelle 2020/12) liegt unterhalb der Kavalan-Hochebene und wurde in den 1960er Jahren verlassen. Zwischen den eingestürzten Gebäuden und in den Straßen fanden sich verhältnismäßig viele antike Funde von hellenistischer bis in osmanische Zeit. Daher ist nicht auszuschließen, dass der Ort auf eine antike Besiedlung zurückgeht. Weitere Siedlungsspuren befinden sich am westlichen Rand der Hochebene. Hier weisen Mauerzüge und Keramik auf eine Siedlungsaktivität von klassischer Zeit bis in die Spätantike hin (Fundstelle 2020/07). Verstürzte Mauern einer weiteren kleinen Siedlung oder eines Gehöfts befinden sich außerdem am südöstlichen Rand der Hochebene (Fundstelle 2020/13). Ein Grund für die Besiedlung von Kavalan lässt sich anhand der vielen Terrassierungsmauern nachvollziehen: Durch die Terrassierung des gesamten Geländes entstanden Flächen, die eine landwirtschaftliche Nutzung ermöglichten. In diesem Zusammenhang sind auch mehrere Quellen auf der Hochebene zu erwähnen, die heute als Viehtränken eingefasst sind und auch im Hochsommer noch Wasser schütten.

Besondere Erwähnung verdient der Fundplatz auf dem Yeldeğirmen, einem rund 100 m langen und 50 m breiten Geländesporn, der sich vom Sarımsaklı ausgehend in die Ebene zieht (Abb. A4.6). Auf diesem Sporn befinden sich die Überreste von mindestens neun Tumuli sowie einem Rundbau (Fundstelle 2020/08). Die Tumuli haben Durchmesser zwischen 5 m und 10 m und verteilen sich über den gesamten Geländerücken. Neben ihren Umfassungsmauern ist bei einigen noch eine aus Steinen gesetzte Grabeinfassung im Zentrum zu erkennen. Anhand der Keramik lassen sie sich in spätklassische bis späthellenistische Zeit datieren. Zentrales Element des Fundplatzes ist ein Rundbau mit einem Außendurchmesser von 11 m, der sich im nordwestlichen Bereich befindet (Abb. A4.8). Von den anderen Tumuli hebt er sich durch die aus geglätteten Andesitblöcken gesetzte Umfassungsmauer ab, die fast vollständig erhalten ist. Im Inneren liegen mehrere, teilweise bearbeitete, langrechteckige

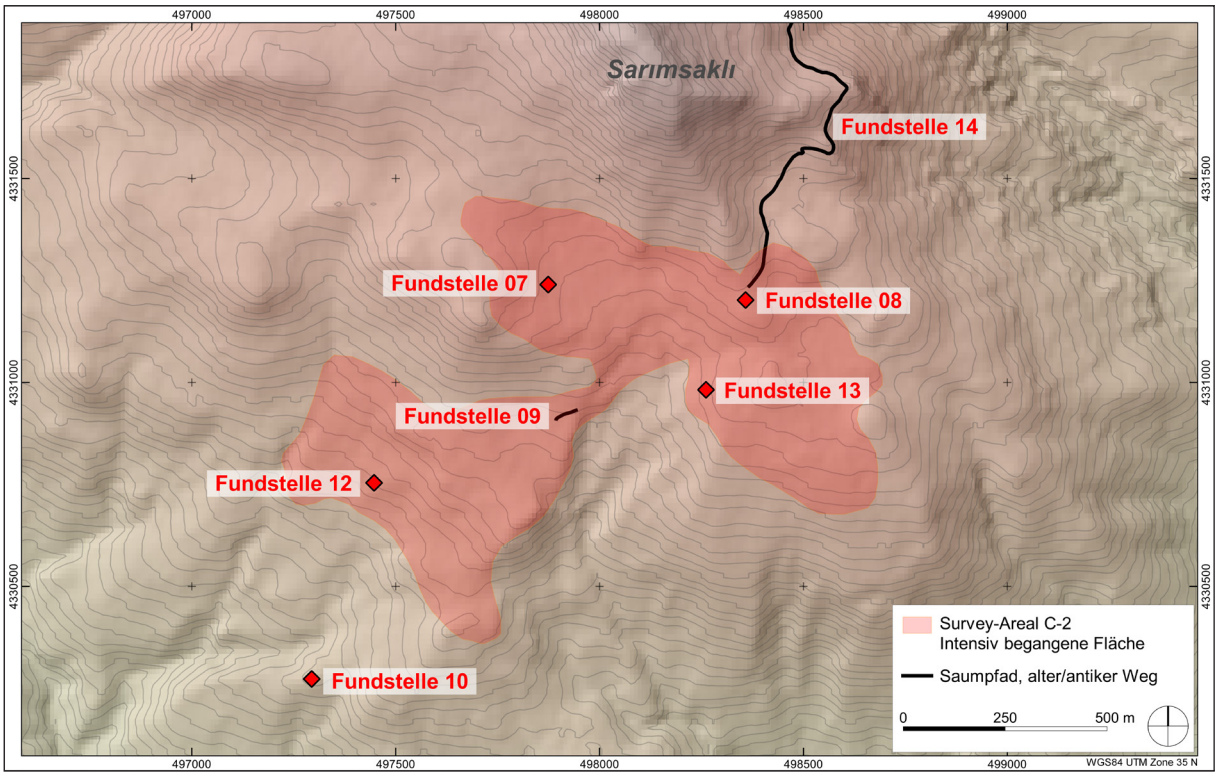

Abb. A4.6 Umland, Kavalan-Hochebene. Survey-Areal C-2 mit Lage der Fundstellen

Abb. A4.7 Umland, Kavalan-Hochebene. Rundbau (rot) auf dem Yeldeğirmen; Mittelgrund: Kavalan-Hochebene (rechts), Geyikli-Tal (links); Hintergrund: Tal des Kaikos (Bakırçay), Kara Dağ, Dikili und Lesbos

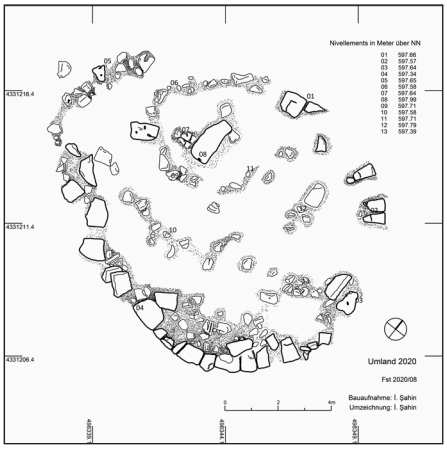

Abb. A4.8 Umland, Kavalan-Hochebene. Plan des Rundbaus auf dem Yeldeğirmen

Blöcke mit Längen von bis zu 1,60 m und Breiten von bis zu 60 cm. Zudem sollen die Schäfte zweier Säulen aus Andesit (Länge 1,80 m, Durchmesser 0,44–0,56 m) vor einigen Jahren aus dem Zentrum des Rundbaus ausgegraben worden sein. Sie konnten 2010 unterhalb des Yeldeğirmen dokumentiert werden, müssen heute aber als verschollen gelten[789]. Erwähnenswert ist zudem der hervorragende Ausblick, der von der Bakırçay-Ebene über das Geyikli-Tal bei Kıroba-Mazılı, die Küste bei Dikili und den Kara Dağ bis nach Lesbos reicht (Abb. A4.7). Erschlossen wurde der Geländesporn über einen Weg, der sich noch heute im Gelände abzeichnet und von der Kavalan-Ebene am südlichen Hang hinauf und am Rundbau vorbeiführte. Dessen Rekonstruktion und Deutung liegt im Dunkeln; am ehesten dürfte es sich um ein weiteres, besonders aufwändiges Grabmonument gehandelt haben, in dessen Umfeld sich die einfacheren Tumuli sukzessive angesiedelt haben. Bedenkt man die Abgeschiedenheit der Lage in Bezug auf die nächstgelegenen städtischen Zentren wie Atarneus und Pergamon, so beeindrucken die Größe und die architektonische Ausstattung (Säulen?) des Rundbaus. Er belegt, dass im Umfeld Pergamons in spätklassischer und hellenistischer Zeit auch jenseits der besonders privilegierten Lagen in den fruchtbaren Randzonen der Kaikos-Ebene wohlhabende Landbesitzer existierten, die über lokale Machtpositionen verfügten und auf dieser Basis besonders prominente Plätze besetzen konnten. In diesem Zusammenhang stellt sich die Frage, ob Abgeschiedenheit in Verbindung mit günstigen Voraussetzungen für Terrassenwirtschaft und Pastoralismus (Quellen und Waldgebiete) in unruhigen Zeiten wie dem 3.–2. Jh. v. Chr. nicht sogar ein Standortvorteil war, vor allem wenn gute Sichtverbindungen und Verkehrsanbindungen hinzukamen.

So besaß die vermeintlich abgelegene Kavalan-Hochebene Verbindungen sowohl ins Geyikli-Tal als auch weiter hinauf ins Kozak-Gebirge. Ein alter, möglicherweise antiker Saumpfad (Fundstelle 2020/09) führt von Eski Mazılı hinauf zur Kavalan-Hochebene. Der gepflasterte, mindestens 1,8 m breite Weg verläuft parallel zum heutigen Feldweg und lässt sich auf einer Länge von 50 m verfolgen. Von Kavalan führt der Weg durch die Berge weiter nach Norden (Fundstelle 2020/14). Er lässt sich auf gut 2 km

789 Mündliche Überlieferung durch Ortsansässige. Im Rahmen des von M. Zimmermann geleiteten Surveys der LMU München in Kooperation mit der DAI-Pergamongrabung.

als gepflasterter Weg, als Treppe entlang eines Steilhanges oder als Hohlweg in den bröckeligen Felsen getreten, verfolgen.

Weiter oben ist bereits auf eine mögliche Siedlungskontinuität seit antiker Zeit im Bereich der verlassenen Ortschaft Eski Mazılı hingewiesen worden. Ähnliches könnte auch für die Begräbnisplätze gelten: Auf einem kleinen Hügel am östlichen Fuß des Yeldeğirmen mit den antiken Grabhügeln liegt ein osmanischer Friedhof, der bis in die 1960er Jahre von den Bewohnern von Eski Mazılı genutzt wurde. Eine solche räumliche Nähe und Standorttreue antiker Grabbezirke und osmanisch-neuzeitlicher Friedhöfe konnte bereits in der Bakırçay-Ebene bei Süleymanlı nahe Teuthrania festgestellt werden[790].

Im Bereich des Survey-Areals C-2 konnten wir eine noch weitestgehend intakte Kulturlandschaft mit einer mindestens 2500-jährigen Nutzungsgeschichte untersuchen. Sie verdient besonderen Schutz und könnte zukünftig zugleich als Ziel für den kulturinteressierten Wandertourismus ausgewiesen werden.

Marmorarchitektur einer mutmaßlichen römischen Villa bei Bozköy sowie weitere Siedlungsspuren und Tonvorkommen in ihrer Umgebung

Nordwestlich des Dorfes Bozköy liegt ein bereits im Vorjahr untersuchter Siedlungsplatz der römischen Kaiserzeit mit einer Baustruktur aus Opus caementicium, marmornen Baugliedern und Resten von Wand- oder Fußbodendekoration aus Marmor sowie einer anhand von Fehlbränden nachweisbaren Produktionsstätte für Baukeramik und Amphoren (Fundstelle 2020/16)[791]. Bei Nacharbeiten wurde auf dem Gelände ein weiterer, möglicherweise antiker Mauerabschnitt entdeckt. Er ähnelt den typischen Grundstücksmauern, die die Olivenhaine in dieser Gegend umgrenzen, unterscheidet sich von ihnen jedoch durch die Versetzung der Bruchsteine in Mörtel.

Einen Hinweis auf die Existenz groß dimensionierter Marmorarchitektur liefert der Fund eines stark beschädigten marmornen Giebelgeisons mit Konsolen (120 cm × 90 cm) im Jahr 2019. Anhand seiner Maße und der bekannten Proportionsverhältnisse römischer Architektur wurden erste Hypothesen zu den Dimensionen des zugehörigen Bauwerks entwickelt (Abb. A4.9)[792]. Demnach könnte das Geison zu einem Giebel mit einer Breite zwischen 3,87 m und 7,87 m gehören[793]. Die sichere Zuordnung zu einem bestimmten Gebäudetyp ist ohne Ausgrabung nicht möglich. Dennoch sollen wenigstens die im Kontext von Villenarchitektur theoretisch möglichen Optionen kurz skizziert werden: Ein Giebel in den genannten Dimensionen wäre denkbar als Abschluss des risalitartigen Vorbaus eines Portikus, wie wir ihn z. B. von der Villa der Poppea in Torre Annunziata oder aus Villendarstellungen in den Vesuvstädten kennen[794], eines Propylons, überliefert in der Villa des Herodes Atticus in Marathon[795], oder auch als Bestandteil eines Nymphäums oder einer Ädikula-Architektur[796]. Die oben vorgelegten Hypothesen zu

790 Pirson 2020, 216–219 (B. Ludwig – Z. M. Aksan – F. Pirson).

791 Pirson 2020, 214–215 (B. Ludwig – Z. M. Aksan – F. Pirson).

792 Der Rekonstruktionsentwurf basiert auf Untersuchungen von A. Skolik (Athen) und 3D-Modellierungen von O. Bruderer (Zürich).

793 3,85–4,11 m bei tetrastyler pyknostyler Ordnung, 5,95–6,38 m bei hexastyler pyknostyler Ordnung, 4,67–5,00 m bei tetrastyler systyler Ordnung und 7,33–7,87 m bei hexastyler systyler Ordnung.

794 Clarke 2018 Abb. 4, 1; Zarmakoupi 2018 Abb. 5, 3, 5, 9, Taf. 1.

795 Papaioannou 2018, 343 Abb. 19, 9.

796 Ein Nymphäum ist in der Lechaion Villa in Korinth überliefert: Papaioannou 2018, 339 Abb. 19, 8.

den Dimensionen des Bauwerks werden sich im Idealfall mit weiteren geophysikalischen Messungen in Bozköy verbinden lassen, von denen wir uns zusätzliche Informationen für die Interpretation dieses bemerkenswerten Fundplatzes erhoffen.

Etwa 300 m südöstlich der mutmaßlichen Villa konnten die Überreste eines weiteren Gebäudes festgestellt werden, dessen Trümmer auf einer Fläche von 9 m × 3 m zutage gepflügt worden waren (Fundstelle 2020/19). Darunter fanden sich Bauglieder aus lokalem Kalkstein und Andesit, Ziegel mit

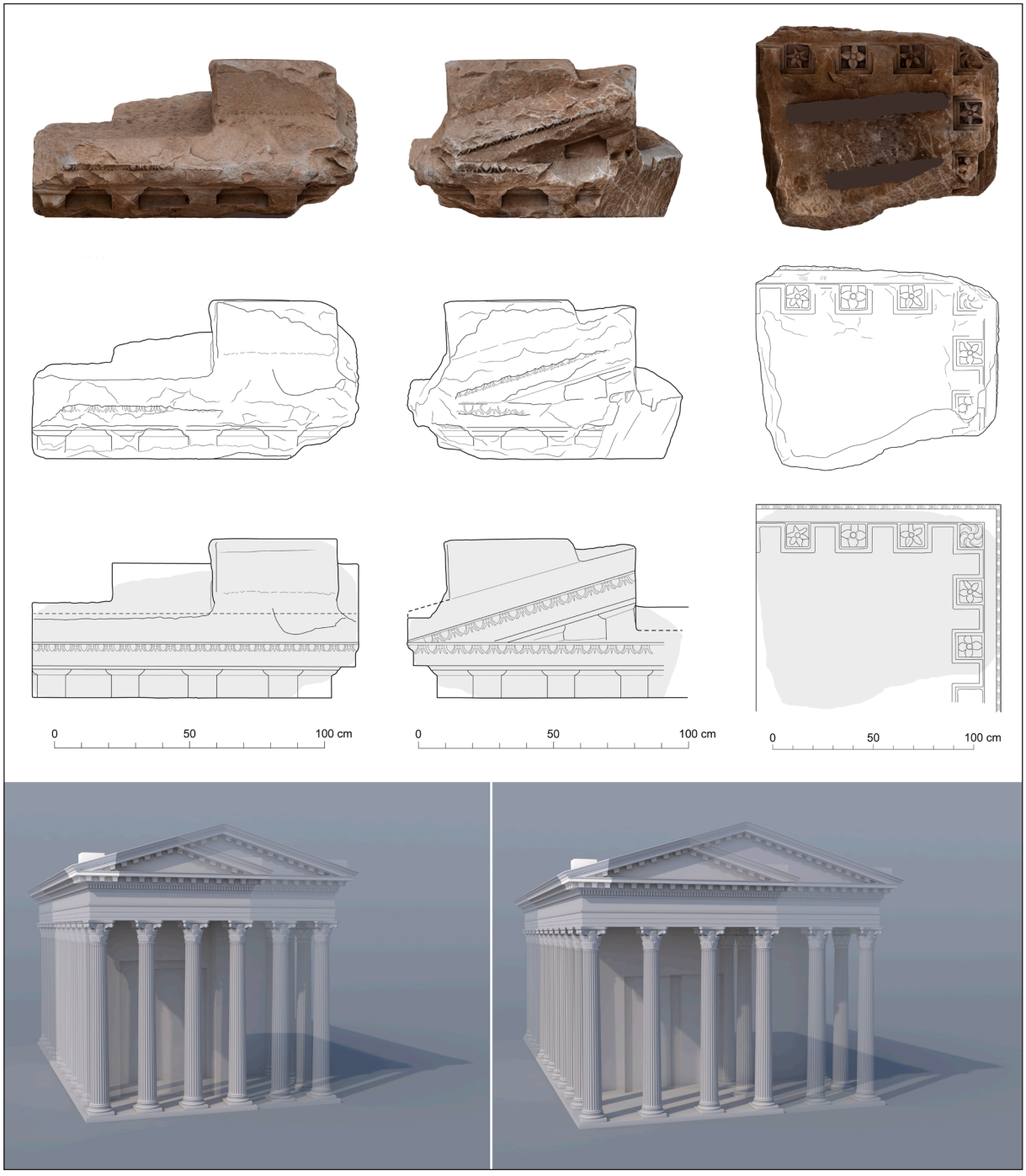

Abb. A4.9 Umland, Fundstelle 2019/07 bei Bozköy. 3D-Modell, Zeichnung und Rekonstruktion des Giebelgeisons (links, vorne, unten) sowie hypothetische Rekonstruktion der pyknostylen oder systylen Fassade anhand des Proportionssystems des Giebelgeisons

auffälligem hohem Strohzuschlag sowie einige fehlgebrannte oder verbrannte Ziegel. Ausreichend datierbare Keramik konnte hingegen nicht gefunden werden. In der näheren Umgebung lagen jedoch einige Marmorfragmente, wie sie auch bei dem nahegelegenen Landsitz gefunden wurden.

250 m östlich der Gebäudereste und 500 m südöstlich des Landsitzes mit baukeramischer Produktionsstätte befindet sich eine ca. 1,5 km² große Senke in der stark tonhaltige, rot-braune Sedimente an der Oberfläche anstehen (Fundstelle 2020/17). Erwähnenswert im Zusammenhang mit diesem obertägigen Tonvorkommen ist insbesondere die gute Plastizität des Materials sowie dessen Zusammensetzung. Das stark tonhaltige Sediment ist sehr glimmerarm und scheint ersten Einschätzungen nach auch in seinen sonstigen Bestandteilen den bekannten pergamenischen Fabrikaten zu entsprechen[797]. Man kann außerdem davon ausgehen, dass die nahe Produktionsstätte in direkter Verbindung mit diesem Tonvorkommen steht. Weitere archäometrische Analysen sind zur Klärung der Zusammenhänge unerlässlich, aber schon jetzt bietet das Areal einen vielversprechenden Ausgangspunkt für weiterführende Untersuchungen zu den Zusammenhängen zwischen Tonlager- und Produktionsstätten in der Mikroregion Pergamon.

Antike Gebäudereste in der Bauschuttkippe (Çöplük) von Bergama

In einer ehemaligen, heute als Bauschuttkippe genutzten Kiesgrube am Stadtrand von Bergama, befinden sich rund 2 km südöstlich des Stadtberges von Pergamon die Überreste eines antiken Gebäudekomplexes (Fundstelle 2020/01), auf die wir durch lokale Mitarbeiter der Pergamongrabung aufmerksam gemacht wurden. Die mächtigen Schichtpakete aus fluviatilen Sedimenten des Bergama Çay (Selinus) überdecken das aufgehende Mauerwerk teilweise noch, da dieser Bereich vom Kiesabbau ausgespart wurde[798]. An mehreren Stellen treten insgesamt elf Mauerwerksabschnitte zutage, die teilweise noch bis auf eine Höhe von 3–4 m erhalten sind (Abb. A4.10). Dabei handelt es sich sowohl um die Außenmauern des Komplexes mit einer Stärke von rund 70 cm als auch um schmalere Innenmauern mit Stärken zwischen 40 cm und 50 cm. Das Mauerwerk besteht aus mörtelgebundenen lokalen Geröllen. Neben einem Fundamentabsatz im Innenbereich sind an einer der südwestlichen Außenmauern noch der weiß-graue Außenputz sowie ein Ziegeldurchschuss kurz unterhalb der erhaltenen Mauerkrone zu erkennen. Die einzelnen Mauerwerksabschnitte lassen sich zu einem Gebäudekomplex mit einer Außenlänge von ca. 40 m × 40 m rekonstruieren. Zudem können mehrere Einzelräume im Osten der Anlage angenommen werden. Das wenige obertägig auffindbare Fundmaterial wird späthellenistisch und frühkaiserzeitlich datiert, das jüngste Stück lässt sich in das 1. Jh. n. Chr. einordnen. Lage, Erscheinungsbild und Grundrissdisposition des Gebäudes lassen am ehesten an eine landwirtschaftliche Anlage im Vorfeld der Stadt denken[799].

797 Die vorläufige Einschätzung erfolgte durch A. Keweloh-Kaletta (Leipzig) und Ph. Bes (Leuven).

798 Zu Aufbau der Sedimente und ihrer Interpretation, siehe Pirson 2020, § 111–115.

799 Pirson 2021b Abb. 12.

Abb. A4.10 Pergamon, Stadtrand Bergama. Teil der südöstlichen Außenmauer des Komplexes mit dem Stadtberg von Pergamon im Hintergrund

Eidesstattliche Erklärung

Hiermit erkläre ich, dass ich die Dissertation *Beyond the City of Pergamon – A Landscape Archaeological Study of the Pergamon Micro-Region from the Hellenistic to the Roman Imperial Period* selbstständig angefertigt und keine anderen als die von mir angegebenen Quellen und Hilfsmittel verwendet habe.

Ich erkläre weiterhin, dass die Dissertation bisher nicht in dieser oder in anderer Form in einem anderen Prüfungsverfahren vorgelegen hat.

Berlin, den

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Bernhard Ludwig

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