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The Hinterland of *Nikaia/Nicaea/Iznik.* Analyzing the Hellenistic, Roman, and Late Antique Bithynian Landscape through Remote Sensing and GIS Techniques

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The Hinterland of Nikaia/Nicaea/Iznik.
Analyzing the Hellenistic, Roman, and Late Antique Bithynian Landscape through Remote Sensing and GIS Techniques

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With this paper, we present the first exemplary results of the Topoi A-6-6 Project “The Economic Landscape of the Hellenistic, Roman and Late Antique Bithynia. Iznik Intensive Survey Project” (2013–2016), focusing on the hinterland of Nikaia/Nicaea/Iznik during the Hellenistic, Roman and Late Antique periods. For this study we used a body of integrated landscape archaeological methods including remote sensing techniques, archaeomorphological analysis, and extensive and intensive fieldwork in test areas, as well as GIS-based mapping and spatial analysis.

Landscape archaeology; survey; remote sensing; GIS; ancient economy; Nikaia; Nicaea; Iznik

1 Introduction

This paper discusses the first exemplary results of the Topoi A-6-6 Project “The Economic Landscape of the Hellenistic, Roman, and Late Antique Bithynia. Iznik Intensive Survey Project” (2013–2016), analyzing the hinterland of Nikaia/Nicaea/Iznik (henceforth Nicaea) during the Hellenistic, Roman, and Early Byzantine periods.

While the literary and epigraphic sources from the urban center of Nicaea and its extensive and well-connected agricultural hinterland are abundant, the archaeological

We would like to thank Mustafa Sahin and Christof Berns for the organizational support during the field survey conducted by B. Weissova around Iznik.

1 For more information on A-6-6, see http://www.topoi.org/project/a-6-6/ (visited on 09/10/2019).
3 On the administrative and economic issues of the province, Dion Chrysostom (Discourses) and the letters of the Younger Pliny to Trajan provide a range of literary evidence; on the administrative issues and impact of the army on the Bithynian economy, see Salmeri 2008, 187–206.
5 Magie 2015, 589.
information on the regional rural landscape and settlement pattern is scarce. Accordingly, the historical-geographic definition of the chora of Nicaea is based almost exclusively on the epigraphic evidence.6 Among others, the inscriptions offer new information regarding the socio-economic role of the nucleated settlements (village communities) in the territorial organization.7

The research questions addressed in the framework of the project concern the archaeological definition of the local settlement history; typology of the sites and their function (villae, farms, villages); land use8 and exploitations of resources;9 production and distribution of food;10 and, finally, ceramic commodities from the Hellenistic to the Late Antique periods,11 with a focus on relations between the town and the countryside. In order to answer the outlined questions, we use a range of integrated landscape archaeological methods including remote sensing techniques, archaeomorphological analysis, extensive and intensive fieldwork in test areas, GIS-based mapping, and spatial analyses of the detected features.

Within the framework of the project, the PhD thesis of Barbora Weissová12 focuses on the definition of spatial and quantitative proxies suitable for studies of the regional economy, development of settlement patterns, and the road system,13 as well as on the interdependencies between regional and supra-regional scales. The collected data was processed using a multi-scalar GIS-based approach. The macroregion encompasses the entire northwest Asia Minor, the microregion is limited to the hinterland of Nicaea. The analyzed time-span covers the broad period from the Hellenistic until the Early Byzantine Era, i.e. from the 4th century BC until the 6th century AD.14 The available archaeological datasets differ in terms of the scale. The macroregion offers a sufficient amount of data for analyses of: the epigraphic evidence, studied in bulk as well as divided into topics relevant to the development of the economic situation; the settlement patterns, with an emphasis on the analysis of the urbanization; and the road system, with a special focus on the maintenance and upkeep documented by milestones. The microregional scale acts to supplement this information with a comparative analysis of the extent of the intramural areas of cities and related population estimates; a functional and spatial analysis of the

7 On the village economy in Asia Minor, see Ruffing 2009, 127–145. On the village feasts (oinoposia) on the northern shores of the Iznik Lake, see Dörner 1978, nos. 15–18; Mitchell 1993, 187; and Anagnostakis and Boulay 2014, 27.
9 On the good fish, which the river Pharmutios brings to the Nikaia Lake, see Şahin 1987, 50. On the Bithynian cereals, as well as on the purple silk from Nikaia listed in the Diocletian Edict on Prices, see Şahin 1987, 53.
10 See Anagnostakis and Boulay 2014, 25–49 on the wine economy in the Roman and Late Antiquity Bithynia. On olive oil production in the Late Antiquity see Anagnostakis and Boulay 2014, 43. On the olive oil economy in Asia Minor, see Mitchell and Katsari 2005.
11 The lack of archaeological data for the region emerges from the survey of recent bibliographic essays on ceramics and settlement (Costa 2013, 91–130; Zerbini 2013, 41–60).
12 Weissová 2019.
13 For the first outcome of the study of the development of the road system, see Weissová and Pavúk 2014, 11–21.
14 The chronological delimitations use the following criteria: the Hellenistic period is delimited between the years 336 and 74 BC; and the Roman period commences in 74 BC (Errington 2008, 287), when Bithynia was given to Romans in the will of its last King Nikomedes III (Jones 1998, 157). The Early Byzantine/Late Antiquity period is delimited by the death of Theodosius I in AD 395 and the death of Justinian in AD 565 (Bury 1958).
hinterland of *Nicaea*, including hints about the sources of local and imported marbles, exploitation of the hinterland, etc.

An archaeomorphological analysis by Robin Brigand aims to integrate the historical-archaeological study by proposing a preliminary synthesis of the urban and rural morphologies of the plain to the east of Lake Iznik. The study addresses questions about the land use history and its interplay with the history of the local settlements. Furthermore, it identifies the layout and the hybridization of the landforms, focusing on a global understanding of the long-term landscape formation and transformation and on the phenomena of the transmission of the landscape features.

The macroregion is located in northwest Asia Minor (Fig. 1), it spreads over 42,777 sq. km and falls into two modern regions, the Marmara in the west and the Black Sea region in the east. The borders are defined with the primary aim of encompassing the entire territory of ancient Bithynia, although the delimitations shifted several times during the periods under discussion. As a decisive factor, the spatial distribution of all the urban settlements that were undoubtedly part of the territory has been adopted, based on the literary evidence. In the following, the borders have been defined according to the natural geographic delimitations, so that the resulting area includes all the settlements and their hinterlands. The ensuing borders are described hereafter, starting in the west and continuing clockwise. The western border is created by the western bank of the

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15 The utilized data are of a middle scale due to the limitations of the resolution of the available legacy geodata.
16 On the archaeogeographical approach, see Brigand 2015.
17 On the description of the Marmara region, see Dewdney 1971, 151–161.
19 These are the 12 cities mentioned by Pliny the Elder in *Naturalis Historiae* 5, 43: *Chalcedon*, *Caesarea Germanica*, *Prusias ad Mare*, *Prusias ad Hypium*, *Cretia Flaviopolis*, *Apamea*, *Prusa ad Olympum*, *Nicaea*, *Nicomedia*, *Iuliopolis*, *Claudiopolis*, and *Byzantium*. 
Ulubat Lake (Apolloniatis Lacus) and further northwards by the Mustafakemalpaşa River (Rhyndacus), shores of the Marmara Sea (Propontis), and, finally, the Bosporus (Bosphorus). The entire northern borderline follows the Black Sea coast (Pontus Euxinus), reaching in the east as far as the estuary of the Bartın River (Parthenius). The eastern boundary follows for the first ca. 50 km the right bank of the Bartın River, from its estuary inland against the stream, towards the southeast. The river then turns eastwards and the border continues to the south, crossing the plateau. As it reaches the Kirmir River (Hieros), the border follows parallel to the river’s left bank, the maximum distance not exceeding 15 km south/southeast from the river. The Kirmir River flows into the River Sakarya (Sangarius), thus, joining the southern delimitation of the territory. The southern border is in fact a direct line, leading from the southern shore of the Ulubat Lake eastwards, including the northern slopes of the Uludağ Mountains (Olympus) and continuing along the left bank of the Sakarya River to the junction with the Kirmir River, i.e. the eastern border.\(^{20}\)

The territory is characterized by a narrow strip of fertile land along the shores of the sea, with an elevation ranging between 0 and 200 meters above sea level.\(^{21}\) The western shore offers several places with more extensive areas of fertile lands surrounding lakes, as in the case of the microregion (see below). The upcountry is for the most part hilly or mountainous, with plateaus cut by river valleys that empty into the surrounding seas. The highest mountain, Mount Olympus, reaches 2543 meters above sea level and is part of the Uludağ Mountains, creating the southern border of the area. The macroregion is tectonically highly active because the Northern Anatolian Fault (henceforth the NAF) intersects the territory.\(^{22}\) The 1500 km long North Anatolian Fault Zone (the NAFZ)\(^ {23}\) bifurcates into three branches to the east of the Marmara Sea, affecting three major cities of the analyzed area: Izmit (Nicomedia), Iznik (Nicaea), and Bursa (Prusa ad Olympum).

2 The microregion

The microregion (Fig. 2) is situated on the eastern shore of the largest freshwater lake in Bithynia, the Iznik Lake (Askania Lacus),\(^ {24}\) and it can be defined as the immediate hinterland of Nicaea (Fig. 3).\(^ {25}\) The analyzed area covers ca. 161 sq. km and includes fertile flatlands and foothills of the mountain ridges running north/northeast and south of the city. The northern and northeast borders of the Nicaea’s hinterland are formed by the Samanlı Mountains (reaching 1227 meters above sea level); the southern border by the Katırlı Mountains (reaching 1280 meters above sea level). Both ridges functioned as natural protective barriers. The western side of the town was protected by the lake and only the eastern side opened to the plain leading further to the east. For a view on the hinterland of Nicaea with the Iznik Lake on the horizon, overlooked by the foothills of the Samanlı Mountains, see Fig. 4.

Two rivers, the Karasu Dere (Pharmutios) and the Kiran Dere, dominate the river system. Both come from the Samanlı Mountains and empty into Iznik Lake, supplying the microregion with fresh water. The River Garsak (Ascanius)\(^ {26}\) plays the important role of connecting the territory with the sea, running from the western shore of Iznik Lake to

\(^{20}\) On the definition of the southern border, see Smith 1854, 405.
\(^{21}\) Foss 2000a, 785.
\(^{25}\) For geographical and topographical descriptions of the town and its hinterland, based on information gained from ancient literary sources and inscriptions, see Şahin 1987, 109–111 (IK Iznik, no. T47).
the Marmara Sea and emptying at Kios (*Prusias ad Mare*). The Iznik Lake is the largest freshwater lake in the south Marmara region, as well as the fifth largest natural lake in
Turkey. The length of the lake in the east-west direction is approximately 32 km, while its widest part is 11.5 km. For the most part, the lake is over 30 meters deep (max. 80 meters), making it one of the deepest lakes in Turkey.\textsuperscript{27} The lake is of a tectonic origin, located directly on the middle branch of the NAF.\textsuperscript{28}

3 Sources of data

3.1 Archaeological datasets

The sources of the regional archaeological datasets are different for each of the examined scales. The macroregional study is based upon legacy data, for the most part compiled in the Barrington Atlas of the Greek and Roman World,\textsuperscript{29} supplemented by the Map-by-Map Directories.\textsuperscript{30} The basic dataset has been further enriched with information from several settlements published elsewhere; the richest source appears to be the notes of travelers recorded before the end of the 19th century;\textsuperscript{31} archaeological works were surprisingly scarce.\textsuperscript{32}

Besides the above-mentioned evidence, the dataset in the microregion is complemented with information collected during the field survey. With an aim to reconstruct the hinterland of \textit{Nicaea} and perform its functional analysis, the legacy data targeted in the terrain encompassed not only settlements published in the Barrington Atlas,\textsuperscript{33} but all traces of

\textsuperscript{27} Bahadir and Özdemir 2011, 4; Ülgen et al. 2012, 90.
\textsuperscript{28} Ülgen et al. 2012, 88.
\textsuperscript{29} Talbert 2003, maps 52 (\textit{Byzantium}), 53 (\textit{Bosphorus}), and 86 (\textit{Paphlagonia}). Hanson 2011, 237 compared the Barrington Atlas with other available sources and confirmed that the Atlas is the most informative and thorough source of data concerning settlements in Asia Minor.
\textsuperscript{30} Map 52 \textit{Byzantium} (Foss 2000a, 785–795), Map 53 \textit{Bosphorus} (Foss 2000b, 796–802), Map 86 \textit{Paphlagonia} (Foss 2000c, 1217–1225).
\textsuperscript{31} Mainly, Anton 1895, 41–115; von Diest 1889, von Diest 1895, 1–40; von Diest 1898; von der Goltz 1894.
\textsuperscript{32} For instance, Aybek and Öz 2009, 327–342; Aybek and Öz 2010, 313–328.
\textsuperscript{33} Talbert 2003, Map 52; Foss 2000a, 785–795.
past activities documented in the territory, including prehistoric settlement mounds, funerary monuments, quarries, and bridges.

3.2 Geographical and geological datasets

Geographical characteristics of the analyzed region are based on the combination of the topographical map (scale 1:25,000) covering the territory of the modern district of Bursa and the digital elevation model of the entire macroregion. The topographical maps were published by the General Command of Mapping of the Turkish Ministry of National Defense in 2001, based on aerial photography taken in 1997. The digital elevation model of the region is based on the combination of SRTMs and ASTERs, further processed to reveal a terrain model (as presented in Figs. 1, 2, 3). The detailed analysis of the microregion was possible based on the Corona KH-4 captured in 1963 (see Fig. 3).

Since the United States Geological Survey (USGS) offers information concerning geological settings, including digitized maps of soils and lines of faults (see Figs. 1 and 2), it represents the main source of the relevant geological data used in the work.

4 The geodatabase

In order to facilitate storing, querying, and visualizing the heterogeneous datasets collected during the work with the legacy data, as well as data from the survey in the field, a PostgreSQL database has been created for this project (for part of the database structure, see Fig. 5). The map in Figure 6 shows an exemplary selection of features dated to the Roman period (geographically rectified settlements, milestones, bridges, and reconstructed roads) visualized using the spatially referenced database. Now that they are stored in one database, the data and their attributes are streamlined and unified to enable further analyses.

34 French 1967, 49–100.
35 To the funerary monuments belong hypogea (Firatlı 1974, 919–932; Yalman 2000, 121–125, 129; Ermiş 2000, 192–217; Ermiş 2001, 121–139); flat grave (Yalman 2000, 96–99); vaulted grave chambers with dromos (Yalman 1994, 425–435, plates 161–188); one grave chamber in a sarcophagus form (Pococke 1743, 122–123, plate LX; Laborde 1838, 38, plate XV, 33; Texier 1882, 109; Schneider 1943, 7–8, plate 3; Rodenwaldt 1943, 5–7, figs. 2, 3; Kleiner 1957, 8, plate 5, nos. 2, 3; Berns 2003, 238–239, plate 21, nos. 1, 2); one rock cut grave monument (Yalman 2000, 96–99); one obelisk (Pococke 1743, 123, plate LX; Texier 1882, 109–110; Schneider 1943, 7, plates 1, 2; Sahin 1979, no. 85; Berns 2003, 159, 162); a massive reef rising above Nicaea with rock cut busts (Sahin 1979, plates 4, 5, no. 38.); and one rock cut sanctuary (Yalman 2000, 93–94).
36 Yalman 2000, 61–62, 94.
38 Courtesy of the Geological Department, Uludağ Universitesi, Bursa, Turkey.
39 The Shuttle Radar Topography Mission (SRTM), created by the United States National Aeronautics and Space Administration (NASA). Utilized map tiles include SRTM_42_04 and SRTM_43_04. (precision 90 m); URL: http://srtm.csi.cgiar.org (visited on 28/10/2019).
40 The Advance Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 2 was released by the Ministry of Economy, Trade, and Industry (METI) of Japan and the United States National Aeronautics and Space Administration (NASA) October 17, 2011. (30 m precision, due to frequent errors combined with the SRTM); URL: https://asterweb.jpl.nasa.gov/gdem.asp (last visited 24/05/2018).
41 KH-4 stands for the ‘Key Hole 4’, the series of Corona satellite images captured between the February 1962 and December 1963.
42 The maps are available as shapefiles for download at URL: https://energy.usgs.gov/OilGasAssessmentsData/WorldPetroleumAssessment/WorldGeologicMaps.aspx (visited on 18/09/2019).
43 The database was created with a great deal of help from Dominik Lukas (Excellence Cluster TOPOI, Berlin).
Fig. 5 | Part of the database structure focused on finds.

Fig. 6 | Spatial distribution of archaeological monuments and supra-regional and regional roads dated to the Roman period.
5 Survey: methodology and preliminary results

The fieldwork in the hinterland of Nīcaea was conducted in the spring of 2015 within a time-span of three weeks by two people. The main aim of the Iznik Survey Project (henceforth the ISP), was a verification of the legacy data, followed by a selective survey based on the information gained from locals. The methodology of the selective survey was inspired by the work carried out by S. F. Starr and fittingly described by the author as a ‘teahouse method’. In practice, we visited each modern village in the microregion and talked to locals sitting in the teahouse, asking them about possible remains of ancient human activities.

In the course of the three weeks in the field, this methodology enabled us to rectify the geographic position of all the legacy data and, on top of that, localize new features, hitherto unknown to archaeologists. All the features were photographically documented, measured, and thoroughly described. Their geographic positions were recorded with a handheld GPS (with an error not overreaching 3 meters). Dispersions of surface concentrations were approximately estimated with a simple method: when identified, we walked each scatter from the west to the east and from the north to the south, recording the density, character, and chronology of the finds. This approach enabled us to roughly identify the extent of each debris area, the functionality, and the chronological time-span (both based on the character of the detected ceramics and other finds). Subsequently, we surveyed the largest identified scatter intensively and systematically, keeping 10 m distance between the walkers.

The final assemblage available for the microregion reveals a diachronic perspective, including four prehistoric tells covering the time span between the local periods EBA II and LBA I (ca. one thousand years), and seven surface concentrations of pottery and architectural ceramics falling within the time-span between the Hellenistic and the Ottoman periods. Interestingly, besides Nīcaea itself, only one of the concentrations was possible to be identified with a settlement depicted in the Barrington Atlas. All the other six scatters were newly discovered, and, moreover, we were not able to find in situ the two settlements displayed in the Barrington Atlas. This issue was most likely caused by geographical errors of the Atlas, which based on the observations throughout the entire macroregion, reaches about 3 km. As confirmed in the field, the ambiguous geographic positions largely impeded identification of the settlements by a selective survey.

To the assemblage of the verified archaeological features belong 55 funerary monuments dated from the Hellenistic till the Early Byzantine periods: two Roman bridges, two remains of Roman road pavements, eight large and two small quarries (for their spatial distribution, see map Fig. 2) with traces of ancient quarrying techniques (see Fig. 8), one Roman/Early Byzantine cistern, and one structure that, with a high probability, can be interpreted as a Byzantine watchtower or a lighthouse; with earlier phases presumable but not confirmed by finds.

44 Barbora Weissová would like to express her deepest gratitude to Ahmet Ali Altın, who accompanied her during the survey and who helped her greatly when solving everyday problems in the field.
45 Starr 1963, 162.
46 Altogether, there were 20 villages, listed here from the north to the south: Tacır, Gürmüzlü, Ömerli, Orhaniye, İnilkı, Elbeyli, Boyalıca, Çakırca, Hisardere, Karadin, Dereköy, Kaynarca, Çiçekli, Hocaköy, Çamlıbeli, Dirazlı, Demirşık, Müşküle, Göllüce, and Derbent.
47 The systematic survey would not be possible without the great help of two volunteers, Mine Özkılınç and Tilman Maria Kühnel, who devoted their free time and helped us with the total coverage of the concentration.
48 French 1967, 49–100; Pavuk 2015, 81–113; TAY Project Database, URL: http://www.tayproject.org/veritabeng.html (visited on 04/05/2018).
During our visits in the modern villages, we also documented *spolia*, chiefly scattered around the main squares. Recorded *spolia* include parts of columns, funerary monuments, and worked marble slabs. However, to the most outstanding belong five large worked stones, identified as parts of oil or winepresses (Fig. 11). Although they were not found in situ, we suppose that based on their dimensions and a lack of any outstanding representativeness, they were not moved further than a maximum of several kilometers from their original contexts.

Since the microregion was not totally covered by the pedestrian survey, the number of settlements and other monuments does not represent a final quantity, but rather the lowest possible number of archaeological features in the territory. The results of the survey in the microregion confirm the insufficiency of the available legacy data and open

49 In this context it is worth mentioning that the previous Greek name of the future urban centre of Nikaia was Helikoré, which means ‘rich on grapes’, as mentioned and discussed by Merkelbach 1987, 10; Şahin 1987, 1; and, recently, Anagnostakis and Boulay 2018, 25–49.
a possibility to consider an extrapolation of the obtained number of rural settlements within the entire macroregion.

6 Spatial analysis at the microregional scale

The spatial and functional analyses of the geographically rectified/newly identified features focus solely on the Hellenistic, Roman, and Early Byzantine periods, as dated based on the observations and finds detected in the field.

Out of seven scatters, chronologically, five of them fall within the focused timespan (for the detected periods, see Fig. 7). Scatter no. 900 was identified with the settlement depicted in the Barrington Atlas as *Ad Schinae, mutation*, situated on the so-called ‘Pilgrim’s Road’ east of *Nicaea*.\(^{50}\) Its existence is confirmed by a milestone that appeared in the village of Karadin, situated 500 meters north of the *mutatio*, brought by locals from the surrounding fields.\(^{51}\) Finds detected in the scatter date the settlement to a long time-span covering the Hellenistic, Roman, Early Byzantine, Byzantine, and Ottoman periods.\(^{52}\)

Two scatters of pottery and architectural ceramics were detected right next to the ancient quarries situated east and northeast of *Nicaea* in the foothills of the Samanlı Mountains. With a high probability, they can be interpreted as manufacturing centers processing the quarried stones. Scatter no. 901 revealed finds dated to the Hellenistic, Roman, Early Byzantine, Byzantine, and Ottoman periods, scatter no. 904 is dated to the Roman and Early Byzantine periods. The assumption that these were the manufacturing centers support results of the systematic intensive surface survey of the concentration no. 901, situated 1.7 km northeast of *Nicaea* (see map Fig. 7 no. 901 and photo of the surface Fig. 8). The detected halo\(^{53}\) of the scatter spreads over ca. 40 ha, out of which one third features a dense layer of chipped marble (see Fig. 13). This implies that the stonemasonry was taking place in the immediate vicinity of the quarries. Due to the proximity of *Nicaea* and the extent of the quarried areas situated right next to the intensively surveyed scatter, the quarries can probably be interpreted as the main source of building stones used in the town of *Nicaea* itself.

Finally, the two remaining scatters, nos. 902 and 903, are both dated to the Hellenistic and Roman periods and were most likely connected with agricultural activities. Specifically, the concentrations identified in the foothills of the Samanlı Mountains (Fig. 7) were utilized with a high probability for olive oil production. Besides the favorable geographic position on the slopes facing south, the spatial distribution of the oil/wine presses was recorded in the foothills of the mountains south and north of *Nicaea* (see photos Fig. 11 and distribution map Fig. 7). The specification to the olive oil production is based on pollen analyses,\(^{55}\) showing an abrupt increase of *Olea europaea* during the Hellenistic and especially Roman period in the area around Lake Iznik.

Examining the spatial distribution of funerary monuments, they reveal an unexpected pattern, as they do not cluster along the main roads radiating out of the city.\(^{56}\) Unlike,

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\(^{50}\) French 1981; Weissová and Pavúk 2014.

\(^{51}\) *Mutatio Ad Schinae* is listed in *Tabula Peutingeriana* (Miller 1916, 657) and *Itinera Burdigalense* (Cuntz 1929, 92). The identification with Karadin was confirmed by French 1981, 29; Şahin 1981, 10; and Şahin 1987, 145.

\(^{52}\) French 2013, 122–123, in particular the milestone no. 69.

\(^{53}\) The place has been identified with the Kara Tekin Castle built by Crusaders at the time they were besieging Iznik, i.e. during the 1st half of the 14th Century AD (Kaplanoğlu 1997, 121).

\(^{54}\) The term ‘halo’ stands for the entire area featuring any remains of the surface concentration.


\(^{56}\) As it is typical for other cities (for a general description of this phenomenon, see Berns 2003, 130, 132).
for instance, in the case of *Heraclea Pontica*\(^{57}\) or *Assos*,\(^{58}\) the graves are for the most part distributed in the foothills of the mountains. This phenomenon might be explained by an attempt of the inhabitants to keep as much fertile land as possible available for agriculture. However, it is only the first feasible explanation, and this phenomenon requires further analyses.

\(^{57}\) For the road connecting *Heraclea Pontica and Prusias ad Hypium*, see Hoepfner [1964], plan II.

\(^{58}\) Berns [2003], 53–54.
The precise position of the bridges enabled us to rectify the course of the supra-regional ‘Pilgrim’s Road’ leading north of the city. The reconstruction of the eastern segment is based on a Least Cost Path Analysis, as well on the remaining regional roads presented in Figure 7.59

### 7 Archaeomorphological analysis of the microregion

#### 7.1 Lake Iznik

The east-west depression of Lake Iznik is connected to the large North Anatolian Fault that runs along the defiles of Karadin (in the east) and Karsak (in the west).60 It is a rift formed by the stretching of the continental crust, limited to the north and south by compartments raised between 600 m and 900 m. It is, thus, essentially in these east-west limits within which the lake could have extended or retracted. Its level is presently regulated at its outlet in the west of around 83 m (Fig. 12). The first drainage and maintenance interventions seem to date to the Greek and Late Roman periods.61 They were meant to both lower the level of the water table and to facilitate water flow towards Gemlik and the Bosphorus. Given that the depth of the water level is directly dependent on the level of the lake, it is understandable how the voluntary interventions on the western spit sought to regulate the natural tendency of the water to rise by keeping the accumulation of sediments, particularly, towards the outlet.

Three low levels of the lake are documented by Geyer et al.: the first, attested in the 1st century AD, was maintained up to the 5th–6th centuries; the second is attested for the 11th–12th centuries; and the third occurred in the 15th–16th centuries.62 In the

59 For a detailed study on the reconstruction, including the specification of the applied Least Cost Path Analysis, see Weissová and Pavúk 2016, 11–21.
60 This first analysis is based on the following geodata: digital terrain models SRTM, 90 m resolution and digitalization and interpolation of the contour lines of the topographic map (1:25000; 10 m equidistance); topographic maps Bursa H-23-a2; Bursa H 23-b1; satellite images Landsat TM 1985 and Corona KH-4 1963; and a cadastral plan of Iznik.
Fig. 12 | Topography of study area: 1) Lake, 2) Isolines 210 m, and 3) Road system.

synoptic table (Fig. 13), the authors emphasize the remarkable concordance between the chronology of the variations of the level of the lake, on the one hand, and the history of land use in Bithynia, on the other. Thus, the main lacustrine transgressions (6th–8th centuries, 14th century, and 16th–17th centuries) are interpreted as periods of social and environmental upheavals, which would explain the cessation of the maintenance works of the outlet. Conversely, the strong and structured societies were able to carry out interventions on the sandpit.63

The slopes are relatively weak around the edge of the lake; a rise of the water level risks affecting the vast neighboring croplands and also the urban developments and infrastructure, starting with the city of Iznik, the western part of which could be made insalubrious by even a modest transgression. Between 83 m and 140 m, lacustrine or riverine-lacustrine deposits form plates on the lower slopes of the littoral plain, the highest at 55–60 m of relative altitude.64

These very high levels, exacerbated by tectonic movements, date back to the wetter periods of the Pleistocene, and have no correspondence in the Upper/Late Pleistocene. Only the Early Holocene seems to have witnessed a level up to +10–15 m higher. In more recent times, the changes appear limited to an amplitude of around 6 m. A transgression of 6 m implies a submerging of almost 45 sq. km of land, predominantly in the west (the outlet and the spit) and the east (north of Iznik and the southern coastline). The lake’s northern and southern shores have steeper slopes, and the bedrock outcrops from place to place (Fig. 14).

The digital terrain model (DTM) and the Landsat TM (Thematic Mapper) image from June 1985 (Fig. 14) are limited to the littoral plain lying below 210 m of absolute elevation.

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64 Geyer, Dalongeville, and Lefort 2001, 80–82.
The confrontation of these two documents allows us to advance a first reading of the peri-lacustrine geomorphological context, and to introduce the specificity of its eastern part.

The colored composition of the satellite image is as follows: band 5 (1.55–1.75 μm), very sensitive to the moisture of the soils (mid-infrared), is represented by the green channel, while band 3 (0.63–0.69 μm), which allows a facile differentiation between the soils and the vegetation, is found in the blue channel. The band 4 (near-infrared 0.76–0.90 μm), placed in the red channel, renders the waterbodies darker and even black and, the sectors with high chlorophyll activity, red.

We can, therefore, observe that:

1. The torrential cones formed by the accumulation of materials washed from upstream come apart at the end of the main torrents. These alluvial lobes, of small size (from 1 km to 5 km across), are arranged in a fan with a narrow apex and a semi-circular distal side. The satellite image allows an easy identification of the great cone of Karasu, which expands into the lake north of Iznik (1); the one of Sölözdere (7); and the more modest one of Derbent (2), east of the village of Boyalica. The grey shades that characterize them indicate sandy-stony terrains scarcely conducive to water retention, but properly irrigated.

2. The reed areas are easily distinguishable due to their strong chlorophyll activity, which renders them bright red along the lakeshore; their development is promoted by the gentle slopes that continue as a sub-lacustrine platform of shallow depth (depositional scar). This is a pertinent indicator for identifying the areas with risks of submersion.

3. The barrier spits in the eastern part (5), as well as the wet and marshy area upstream of the outlet (6), are well identified. They probably correspond to sectors with crops specific to hydromorphic soils.

To the east, in the plain south of Iznik, at the foot of the southern slopes, we notice a dark band (8) signaling a soil with a strong capacity to retain water. An anomaly, in yellow on
Fig. 14 | Lake Iznik and its coastal plain from the DTM (top) and 1985 Landsat TM imagery (© USGS). 1) Lake and 2) 5 m contour line. The white numbers indicate the main geomorphological units described in the text.

the Landsat image, continuing what appears to be a paleohydrographic corridor, seems to be occupied by meadows and other foraging plants.

Considering the plain east of Lake Iznik, the leading document is the Corona imagery from 1963. In addition to being historical data that provides an opportunity to ascertain the ancient parcellation and hydrographic forms, this document allows one to clearly distinguish the irrigated or wetlands (dark shades) from the dry (some very-permeable, sandy-stony foothills) and unirrigated ones. This is, for instance, the case with the southern foothills of the Iznik plain that despite multiple torrents remain wholly arid. This is why a channel branching from the Kiran was dug into the mountainous ridge in order to supply the villages of Bocakoy, Camdibi, and Dirazali with water.

By confronting this essential data with a DTM developed here by digitizing the contour lines, we can identify roughly three spatial units (Fig. 15).

1. The cone of the Karasu develops between the downcut of the Karasu and the Cevizlik. The strong down cutting impacts the ancient surfaces of the alluvial lobe formed before the diversion of the Karasu westwards. The sedimentary dynamics of the torrents found north-west of Elbeyli – observed in 1963 – as well as those of the Cevizlik have likely helped feed the alluvial ridge. It sinks from an elevation of around 100 m, giving way to a wet area in which the hydromorphic character seems to be accentuated by the shifting of two watercourses.

In this regard, the presence of motor pumps (topographic map 1:25000) and of paleohydrographic forms (Corona KH-4) is revealing. We also note that two major alignments of parcel boundaries and channel-ways, roughly parallel with the contour lines, may mark a time of lacustrine transgression.
2. The cone of the Küçükköy displays a morphology similar to that of the Cevizlik. The upstream sector is entirely irrigated through a parcellation established according to the isoclines and the escape channels that reach the parcels along the radials; it is quickly interrupted by the banks of the lake. The path of the watercourse should continue into the depressed area of the inner-cone in the north, or towards the northern plain of Iznik in the south.

3. The plain of Iznik is divided into two areas. The first is limited by the cone of the Küçükköy to the north and south, by a modest levee that crosses the southern plain of the Karadin defile to Iznik, the latter being likewise only slightly elevated. From north of Cicekli to Iznik, the ancient path of the Kiran takes this somewhat bulged shape for almost 4 km. Between this ancient path and the southern foothills characterized by numerous small alluvial cones, a wide, slightly inclined conch develops. Going strictly along an east-west direction, it is crossed in the middle by the Kiran Channel, dug in the second half of the 20th century. Shortly after the diversion of the Sulama towards Dirazali, this channel borrows exactly the paleohydrographic form observed in the Landsat image (Fig. 15). It is similarly noticeable in the extension of the southern branch of the Kiran from 1963.

This first synthesis allows us to understand in more detail the topographic and hydrographic characteristics of the plain of Iznik. The main points to be kept are: 1. the existence of a vast paleochannel running on an east-west direction, dividing the southern plain at its middle, which forms the base of the most ancient irrigation and drainage channels, beginning with the southern one of the Kiran and 2. immediately to the north and south of Iznik, two vast wet areas seem to collect the runoff waters from the lobe of the Küçükköy, on the one hand, and the northern foothills, on the other.
7.2 Archaeogeographical approach

In the geomorphological context described above, the planned frame that covers the northern and southern sectors of the plain of Iznik shows a new picture. This land division that reproduces a system of regular and periodic bands for almost 20 sq. km has an obvious function related to its relevance for agriculture. It is a hydraulic work meant to lower the level of the water table by regulating the running waters and draining the southern plain. It is possible that this intervention was made at the same time as works on the western barrier spits – maintaining and cleaning the outlet – in order to reduce the level of the lake.

G. Scardozzi made the first study of the planning of the Iznik plain.\(^{65}\) Adopting the methodological approach of the Italian ancient topographic tradition, this research proposed a different interpretation from those that could be provided by a morphological study (Fig. 16). Starting from a planimetric documentation similar to ours (Corona and SRTM DTM imagery), the author focuses on the topography of the ancient city of Iznik and its rural parcellation.\(^{66}\)

1. The orthogonal plan of the Hellenistic city, as documented by Strabo, is a square with a side of 710 m. The perimeter of the walls measures 16 stadia, that is to say 2840 m, and four gates open on the two main axes that meet in the middle of the square.

We note, for instance, that this interpretation is not in agreement with the realities documented in the satellite imagery. For instance, the urban square as advanced by Scardozzi has a side of ca. 660 m (this is, moreover, the width of the bands of the land parcellation), and not 710 m.\(^{67}\) Questions should also be asked with respect to the origin of this measure, which evokes a Roman rather than a Greek metrology (710 m equal 20 actus); this represents a critical point.

2. The division of the cropland develops in line with the urban planning. It proposes a rectangular mesh of 540 × 660 m equivalent to 18 and 22 plethra. Scardozzi then describes the main axes that survived in the landscape.

On the basis of the highly regular morphology of the city (which was mentioned by Lysimachus in 301 BC) and its close connection with the rural parcellation, Scardozzi proposes an early dating of the urban and rural land survey during the Hellenistic period.\(^{68}\) Our study helps refine these first exploratory results, starting with a better identification of the rural parcellation.

8 Results

The field system that structures the plain of Iznik (Fig. 17) consists of regular coaxial bands, of constant (N 2.5°E) and periodic (535 m) orientation. The bands are systematically divided in the middle giving the appearance of a system of strips of 267 m in width. We especially recognize two east-west axes that have a periodicity of 660 m. The first forms the main axis of the city of Iznik. It points towards the outlet of the Cmarlik in the plain until it is interrupted in the area of the Katirci Hill (ca. 150 m elevation). The southern limit of the city, limited by the Byzantine enclosure, which partly takes the path

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\(^{65}\) Scardozzi 2013.

\(^{66}\) Scardozzi 2013, 882–885.

\(^{67}\) Scardozzi 2013, 883, Fig. 3.

\(^{68}\) Scardozzi 2013, 885.
of the Roman one, overlaps the southern path. The latter also aims towards Cmarlik, but foremost towards its confluence with the Kiran. It has a gap of more than 1.5 km where the present-day national road shows a significant break in the orientation.

Apart from these two prominent axes, very few strong limits register according to the theoretical $535 \times 660$ m grid; however, two alignments formed by the parcellation limits at around 700 m and 800 m were found 660 m and 1320 m south of the city, respectively.

The urban plan is strongly regulated and the overlay of an artificial grid allowed the identification of a rectangular module of around $82 \times 73$ m. The value of 82 m corresponds to the distance between the main north-south axes. In many cases, the reference value corresponds to 41 m. The survey of the road axes integrated into this metrological system produces a straight rectangle of ca. $451 \times 511$ m that could correspond to a first delimitation of the urban center.

Recall the metric values observed: 73 m, 82 m, 535 m, and 660 m. Three of them (82, 535, and 660) are multiples of a reference value equal to 41 m (a ratio of 2, 13, and 16, respectively). This simple element warrants the claim of a unitary character of the urban and rural frames, which can be assigned to the Hellenistic Era, perhaps to the 1st century BC, a period during which the city already played an important socio-economic role in the region.

Nevertheless, it was after the conquest by Pompey and the territorial reorganization of Bithynia that Nicaea/Iznik acquired the entire assemblage of the plains abutting the lake.\(^{69}\) It is probably during this period when the first interventions were carried out on the western barrier spits and the level of the lake was regulated. Is it possible to envision an agrarian management during the Roman period? The metrological system seems to invalidate this hypothesis. In fact, two measures are multiples of the value of an actus ($73$, $535$; 2 and 15 actus, respectively). This combination of values related to a Roman metrology and to another, probably Hellenistic one, is interesting in that it may evoke different temporalities involved in the development of the urban and rural frames of Iznik. This is an appealing hypothesis, which remains difficult to prove in the absence of more comprehensive investigations.

Aside from the sector of the Karasu that likely has never been surveyed, due to an instable hydrography and lands too often affected by the lacustrine variations, the plain of Iznik was the subject of planning that, in our opinion, seems meant for two specific reasons:

\(^{69}\) Gonzales 1997, 74.
1. The first concerned draining the southern plain by means of water circulation in order to avoid an eventual clogging of the paleochannel, naturally with the function of a collector (Fig. 17, blue arrow). The situation in the north is similar, in that the frame drains this little plain by supporting the flow of water originating at the alluvial fan of the Küçükköy.

2. In the north as well as in the south, this land lot organization seems to suggest the existence of two wetlands (Fig. 17, grey arrows), directly at the foot of the city. Besides allowing access to the water resources and limiting access into the city, this arrangement reveals two collectors of the hydraulic system of the Iznik Plain.

This analysis sheds light on the hydraulic function of the agrarian planning. In fact, the comparison between the topography and the land lots allows us to argue that this system is related to water regulation and drainage issues. A refinement of this first study will be possible only with the help of high-resolution satellite imagery and extensive bibliographic research of historical land registers, in order to relate the documentary sources with the observed morphology and metrology.

9 Concluding remarks

The main aim of this first synthesis is to outline ways to improve our understanding of the rural landscape around Nicaea. In order to do so, the work combines the whole range of available legacy data and geodata, complemented by new observations based on remote sensing techniques and a limited amount of fieldwork. The applied methodology during the fieldwork can be described as a selective survey, for the most part following local informants and exploring the vicinity of each of the modern villages situated in the immediate hinterland of Nicaea. In order to rectify the primary observations, the
selective survey was combined with an intensive systematic pedestrian survey of one of the identified surface scatters.

Besides numerous spolia, mainly dispersed around the modern villages, the three weeks of fieldwork brought to light 78 archaeologically relevant features, including surface concentrations of pottery and architectural ceramics, funerary monuments, bridges, remains of road pavement, quarries, etc.

The preliminary spatial and functional analysis of the geographically rectified/newly identified features allowed us to identify two of the surface scatters as manufacturing centers that processed the quarried stones, one is the road station Ad Schinae, and, finally, two more concentrations could be connected with agricultural activities.

The spatial analysis of the exploitation of the hinterland indicates a clear division between the northern/southern and eastern foothills of the mountains, which create a natural border of the microregion. Whereas the northern and southern delimitation of the hinterland revealed several oil or winepresses, suggesting concentration on olive oil production or viniculture – narrowed down by pollen analyses to olive oil production – the eastern part of the territory disclosed numerous traces of ancient quarries, cutting deep into the relief of the Samanlı Mountains.

Finally, the road system calculated based on the Least Cost Path Analysis was corrected with the help of the precise positions of two bridges identified north of Nicaea, specifying the route of the supra-regional ‘Pilgrim’s Road’.

The archaeomorphological and archaeogeographical analysis integrates the archaeological information, showing that the agrarian management and the drainage work for water regulation played a key role in the long-term development of, and have an impact on, urban and rural features.

Illustration credits

References

Aksoy 2014

Alpar and Yaltırak 2002

Anagnostakis and Boulay 2016

Anton 1895

Aybek and Öz 2009

Aybek and Öz 2010

Bahadır and Özdemir 2011

Barka 1997

Belke 2013

Berns 2003

Brigand 2015
Bury 1958

Costa 2013

Cuntz 1929

Dewdney 1971

Díaz 1997

von Diest 1889

von Diest 1895

von Diest 1898

Dörner 1978

Ermiş 2009

Ermiş 2011

Errington 2008
Fıratlı 1974

Foss 2000a

Foss 2000b

Foss 2000c

French 1967

French 1981

French 2013

Geyer, Dalongeville, and Lefort 2001

Geyer and Lefort 2003

von der Goltz 1896

Gonzales 1997
Haldon et al. 2014

Hanson 2011

Hoepfner 1966

Hütteroth 1982

Hütteroth and Höhfeld 2002

Izdebski 2013

Jones 1998

Kaçar 2005

Kaplanoğlu 1997

Kleiner 1957

Laborde 1838

Magie 2015
Merkelbach 1987

Miebach et al. 2016

Miller 1916

Mitchell 1993

Mitchell and Katsari 2005

Pavúk 2015

Pococke 1745

Rodenwaldt 1943

Ruffing 2009

Şahin 1979

Şahin 1981
Şahin 1982  

Şahin 1987  

Salmeri 2005  

Scardozzi 2013  

Schneider 1943  

Smith 1854  

Starr 1963  

Talbert 2000  

Texier 1882  

Thonemann 2007  

Ülgen et al. 2012  
Weissová et al. 2019

Weissová and Pavúk 2016

Yalman 1994

Yalman 2000

Yaltırak 2002

Yaltırak et al. 2012

Zerbini 2013
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