Asia Anteriore Antica
Journal of Ancient Near Eastern Cultures

Firenze University Press
www.fupress.com/asiana

Citation: Rocco Palermo (2022). Over the Frontier. Remote Sensing Analysis of the Roman Eastern Borderland in Mesopotamia through Declassified Satellite and Aerial Imagery. *Asia Anteriore Antica. Journal of Ancient Near Eastern Cultures* 4: 89-110. doi: 10.36253/asiana-1659

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Over the Frontier. Remote Sensing Analysis of the Roman Eastern Borderland in Mesopotamia through Declassified Satellite and Aerial Imagery

Rocco Palermo

Università di Pisa
rocco.palermo@cfs.unipi.it

Abstract. This paper discusses the spatial configuration of the Roman easternmost borderland in Mesopotamia through several case studies and, particularly, with the aid of declassified aerial and satellite imagery. Satellite pictures from the 1960s and 1970s have proved to be of incredible value for the archaeological research in the Near East, contributing to a solid advancement in the understanding of large-scale phenomena on long-term periods. This is particularly true for the so-called *late* periods of Mesopotamian history which – traditionally – suffer from an inexplicable lack of terrain data. Although the research has consistently improved in the las decade or so, the support of remote-sensing techniques has open new and fruitful research trajectories on the matter. I will employ legacy aerial data, CORONA and HEXAGON declassified satellite imagery and U2 aerial data to assess some case studies in the region and to provide new insights on such a contested space, now roughly comprised between northeastern Syria and northwestern Iraq.

Keywords. Mesopotamia, Satellite, Landscape, Roman, Syria, Iraq, Aerial.

INTRODUCTION. ROME ON THE EDGE

The easternmost territories of the Roman Empire have received a discrete amount of attention in the past decades, with many works however focusing on socio-economic and historical phenomena, rather than on the proper archaeological records (Millar 1993; Sommer 2008; Edwell 2012). With the advancement in landscape archaeology practices for South-West Asia in the last years, a re-appraisal of the spatial physiognomy of the Roman eastern frontier in Mesopotamia is timing and necessary.

The very first caveat to the analysis of the Roman easternmost territories is that its geographical definition is volatile, and with no fixed points or markers – as, comparatively, the Rhine frontier in Germany (Franconi 2020). This ever mutating and fluctuating zone of interaction roughly com-

prised between Northeastern Syria, Southeastern Turkey, and Northwestern Iraq saw the presence and interchange of three main agents: the Roman Empire, the Parthian, and Sasanian Empires, and a large amount of nomadic and non-sedentary communities of Arabs (Fisher 2016; Palermo 2019). This kaleidoscopic scenario contributed to the social definition of the Roman eastern borderland. Ancient borderland areas presented indeed an invaluable framework for interaction and engagement between different groups, establishing examples of bilateral interplays and reciprocal approaches, as indeed they still do today. In a straightforward view, modern scholars have come to think of borderlands as areas where no major (or hegemonic, in a Gramscian sense) power expresses a firm political and economic dominion (Bates 1975). The relationships between the settled population, whose subsistence was mainly based on agriculture, the nomadic component, which relied on pastoralism, and those who fell somewhere along the spectrum in between contributed to the creation of a specific socio-ecological interface in the contested regions.[1] It is in this complex scenario that our analysis takes place. Given the often-complicated political situation in large part of the historical Roman period Mesopotamia, remote sensing and integrated analysis (combining archaeological, historical, and literary data) have proved to be particularly effective. Despite the basic consideration that ground-truthing operations must be carefully and systematically performed to validate the remote analysis, the mapping and identification process (along with some interpretative analyses) represents the core business of the satellite and aerial imagery driven research in this part of the world.

MAPPING THE FRONTIER FROM ABOVE

Pioneers of Remote Sensing in Mesopotamia

It is a matter of fact that (declassified) satellite and modern aerial imagery came late on the stage in regard to the attempts of mapping the Roman eastern borderland in Mesopotamia. Already in the initial years of the 20th c. the very early endeavors of *Pêre* Poidebard marked the beginning of the *remote sensing* season for North Mesopotamia. Antoine Poidebard was a French military chaplain and skilled pilot who yielded to the archaeological community then and today thousands of aerial images of major sites, cities, and landscape features of the greater Near East, from Lebanon to Jordan, from the Syrian desert to Iraq (Poidebard 1934). Between 1928 and 1929 Antoine Poidebard flew over North Mesopotamia, snapshotting several archaeological features between Nusaybin/Al-Qamishli (anc. *Nisibis*) and the upper Tigris River in North Iraq. This is not the venue to discuss and criticize certain chronological attributions of Poidebard nor to celebrate his vision for the community of landscape archaeology, but rather the work of Poidebard must be integrated and compared with more recent remote sensing data, satellite imagery interpretation, and – fundamental aspect – thorough ground-truthing operations. And yet, the goal of Poidebard was not distant from the core topic of this paper: recognizing traces of the Roman occupation, mobility, and presence – in general – in the easternmost territories of the Empire. Comparing some of the shots of Poidebard with modern aerial and satellite images might therefore provide a useful insight into the archaeological landscape of North Mesopotamia. Poidebard was very much interested in the reconstruction of the itineraries and – in general – the mobility in the *provincia Mesopotamia*, also considering and using – not rarely in a naïve way – the *Tabula Peutingeriana*.[2] Particularly interesting, in this sense, is the coverage of the area that runs from the east-

[1] In this sense, Arabs played a key role. Studies on the interaction between settled peoples and nomadic tribes have proved to be successful in regions such as the Negev or the Jordan Desert, whereas our understanding of the processes of negotiation in Mesopotamia is limited. In general, on the archaeology of nomadic community see Cribb 1991; Szuchman 2009. For detailed overviews of the nomadic segments of Jordan and the Negev, see Finkelstein, Perevolotsky 1990; Rosen 1992. More recently, a Liden-based project is investigating the "Landscape of Survival" in the Jordan Black Desert region, with particular attention to the dichotomy nomads/settled peoples (see Akkermans *et al*. 2014: 186-205; Huigens 2015).

[2] On the Tabula Peutingeriana (Peutinger Map) see Talbert 2010 with extensive references and digital appendices available at: https://peutinger.atlantides.org/map-a/. On the role of the map for the reconstruction of the routes in the region see Altaweel, Hauser 2003. Scardozzi 2014. Palermo 2019: 210-230.

ern bank of the Khabur river to the area of Ain Sinu at the eastern edge of the Sinjar massif, towards the Tigris. Photographs taken over this steppe-like stretch of Mesopotamia now comprised between Syria and Iraq include a large variety of settlements, structures, possible routes, and forts, the chronology of which is difficult to assess. And yet, Poidebard – and many others after him, including the late David Oates – interpreted with firm certainty these material remains as evident traces of the Roman presence in the region. One of the most emblematic cases, for example, is represented by the so-called *"castellum"* located not far from the large pre-classical mound of Tell Brak, in the governorate of Hassake, in northeastern Syria, which I will discuss further on in the paper.

No longer after the flights performed by Poidebard, Sir Aurel Stein flew over the modern Syrian-Iraqi border in search of visible traces of the Roman presence, also supported by the Royal Geographic Society and the Royal Air Force (RAF). The operations carried out by Poidebard stopped in the region of Singara, and – in the 1938 – Stein took over the *task* to investigate the easternmost stretch of the *limes* towards the Tigris and Hatra. This last centre was central to Stein's research question as he had planned to explore its role within the complex system of routes and tracks of the region, also linking it to the evidence from the Peutinger map. Unfortunately, Stein (76 years old at the time) died prior to the completion of his research, which was later fully published by David Kennedy, Derrick Riley (1990).

Declassified datasets

In the last decades satellite and aerial imagery primarily taken for military purposes during the Cold War era by US satellites and spy planes have gained a central and crucial part in the archaeological research worldwide, and particularly in the Middle East. These data have been extensively used by archaeologists to assess several historical phenomena (Ur 2003; Casana, Cothern 2008; Casana 2020: 89-100): from the detection of cultural heritage risks (Stone 2008; Parcak *et al*. 2016; Casana, Laugier 2017) to the identification of large-scale irrigation features (Ur and Reade 2015) and settlement transformation through time (Ur *et al*. 2013; 2021).

However, these very same records have been limitedly used for the study of the Roman borderland areas in Mesopotamia (Scardozzi 2014; Palermo 2016; 2019). Here I propose an overview of the data in our hands: CORONA, HEXAGON, and U2 pictures, before moving to the application of those pictures – and their analysis – to some case studies concerning the easternmost territories of the Roman Empire.

The CORONA Program (1959-1972)

CORONA was the code-name of an US government complex and meticulous espionage program that was ran between 1960 and 1972. The official name of the spy satellite program was CORONA KH 1-4 (where KH stands for *keyhole*). The program was specifically requested by the US government to replace the previous spy spotters employed until then: the U2 program (which I will discuss below) and the GAMBIT KH-7 (Hammer, FitzPatrick, Ur 2022: 2), which were purposely targeting specific structures/facilities during the early years of Cold War. Over the course of the program, more than 100 satellites were employed, with an approximate number of high-resolution pictures taken topping 800.000. The first and foremost technical advantage of these images is their resolution that – depending on the machines used – varies from 20 to 6 feet (60 to 18 m ca). This represents an enormous advantage if compared to other commercially available datasets like SPOT or LANDSAT whose resolution does not match the required standards for site-level exploration in archaeology. The second advantage – especially if compared to GAMBIT – is the much larger spatial coverage of CORONA (and HEXAGON later). Images were classified until made available in the 1996 (first batch) and the remaining part in 2002. They are now freely available as digital images via different online platforms like the USGS's owned Earth Explorer (https://earthexplorer.usgs.gov) and the Corona Atlas of the Middle East setup of the University of Arkansas (https://corona.cast.uark.edu/). Unlike aerial photography which traditionally uses two vertical shots with a high degree of overlap (>50%), satellite imagery, and CORONA particularly, is built upon the usage of two cameras taking a forward

and afterward picture as the satellite passes over. This technique is called stereoscopy. Stereoscopic imagery consists in two pictures obtained with cameras angled at similar degrees (in case of CORONA is ca. 5°) but with different viewing angles, which will result in different shadows and pictures of the same scene. While one single shot is often used for the landscape archaeology purposes of simply detecting archaeological features, the combination of both images would provide much more data in terms of visual information.

Besides the technical aspects of the CORONA images, their wide and successful employment within the archaeological research of Eastern Mediterranean and the Middle East lies in the fact that these images offer a glimpse into a pre-industrialized and less agriculturally exploited landscape, where naturally archaeological features are more visible and/or stand out more clearly.

Since its clearance, the CORONA program has proved to be one of the best sources for landscape archaeologists in SW Asia. Its potential was first assessed by David Kennedy in 1998, then several other studies have used CORONA-based imagery datasets to explore different aspects of the ancient Near East (Ur 2003; Alizadeh, Ur 2007; Hritz 2014). Considering that on many occasions – mostly due to political turmoil – ground-truthing operations in the Middle East might suffer a halt or be forcedly reduced in time and space, the employment of such an interesting remote sensing tool certainly provides useful insights for both the archaeological research proper and studies of cultural heritage and management in endangered areas.

The Hexagon Program (1971-1986)

Starting in 1964, the US government t commenced the development of a new satellite program (KH-9, codename HEAXAGON) that would have followed the successful CORONA. Operated from 1971 to 1986 HEXAGON was the last and longer remote espionage program of the United States during the Cold War. Unlike CORONA, however, only 20 satellites were launched, picturing the world (and mostly the eastern block and the MENA region) from 1971 to 1984 (Hammer, FitzPatrick, Ur 2022: 2). The technical aspects of the HEXAGON images did not differ from the ones that I described while discussing the CORONA program. The real difference between the CORONA and the HEXAGON program lies in the quantity of data provided by the latter. At the end of the program in the mid-1908s, almost 2 million pictures were taken (compared to the ca. 700.000 of CORONA). Another important difference – which is more relevant for the application of these datasets in the archaeological research – is that the panoramic shots of HEXAGON covered an area averagely 3 times larger than the one covered by the CORONA satellites. Lastly, the whole program adopted a cloud-free approach (Oder *et al.* 1992), meaning that the HEXAGON pictures were taken in better visual conditions than CORONA, ultimately enabling the United States government to obtain images of – almost – the entire Asian continent (Hammer, FitzPatrick, Ur 2022: 3) (an interactive map of the total coverage for the HEXAGON program is accessible at this link: https://arcg.is/1HL8fS0).[3] Also, the better resolution of HEXAGON over CORONA was praised by the American espionage system for its ability to detect on the ground small-scale military vehicles, for example. Finally, HEXAGON images were declassified in 2011, but they have been made available to the public only recently (from 2020).

The U2 aerial imagery (1956-1960)

The last set of declassified images to be openly released by the US government belongs to the U2 program. These photographs were part of a Cold War era spy program that ran from June 1956 to May 1960 (Hammer, Ur 2019: 108). The code-name of the mission was CHESS and the flights were organized in three different locations: (A)Wiesbaden, (B) İncirlik/Adana, and (C)Alaska). Teams operating at B and C were also moved occasionally to

[3] A complete and interactive version of the article by Hammer, FitzPatrick, and Ur is available here: https://storymaps.arcgis.com/stories/4a9b3b59888746fa9390f7f1f9c5add9 (Last access: December 2022).

Pakistan (B) and Japan and Southeast Asia (C).[4] Unlike CORONA and Hexagon, however, U2 pictures are not publicly available yet and, in fact, they are stored in a cold facility in Kansas and can be accessed (for scan and pictures) at the NARA (National Archives and Records Administration) laboratories and cartographic rooms in College Park, Maryland. The enormous advantage of the U2 pictures – if compared to the satellite datasets – lies in the higher resolution of the aerial shots, counter-balanced, however, by a much smaller coverage in terms of spatial extent. Another advantage is that U2 aerial pictures provide an even earlier datasets if compared to later satellite records, thus enabling the researcher to have a glimpse over specific areas of the greater Near East that would have been heavily industrialized and urbanized in later decades. As in the case of the satellite data, the U2 images must be subject to accurate and precise geo-referencing to be fully and successfully employed in the archaeological research. Each of the U2 planes operating during the program mounted a B-camera systems (composed by two lenses, the successor of cameras A1 and A2 previously used in the program). This is a very high-resolution and panoramic machine. It took a vertical picture and then three pictures to the left and to the right, generating a horizon-to-horizon image. The later shots are, naturally, quite stretched and they need precise post-process work in a GIS environment to but accurately used for the archaeological research.

CITIES, SETTLEMENTS, AND LANDSCAPE OF ROMAN MESOPOTAMIA

In the western part of the Roman world, the degree to which conquered lands were integrated depended on the way military unites were dispersed and garrisoned. Their social, economic, and cultural impact was significant, and determined the creation of civilian settlements (*canabae*) that served to sustain daily life at the camp, and later turned into cities themselves (see the case of *Colonia Agrippina*, modern Köln, in Germany). Such crucial locations thrived economically and were involved in both military and civilian life. In this sense, one of the best markers of the Roman military presence in Northern Europe, for example, is undoubtedly the so-called "playing card"-shaped forts, which were widespread along the fringes of the western empire (Breeze 1983; Wamser 2000; Vermeulen *et al.* 2004; Bidwell 2007).

In the East, the Roman army had to necessarily face a different scenario. The Near East, and Mesopotamia in our case, was home to a sophisticated and well-established urban culture, together with long-standing social, political, cultural, and economic traditions. This is the case, for example, of the pre-Roman period cities of North Mesopotamia (Fig. 1). Urban areas, although limited in number if compared to other eastern regions, constituted the core of the *consensus* within the limits of the eastern borderland. This is displayed in the adoption, by the social components of the cities, of certain values of external origin in terms of religion, architecture, economy, and administration that amalgamated with the local social substrate to create the panorama of Roman Mesopotamia. The negotiation of these values shaped the social and physical features of each city; taking place at different levels, this mediation is visible through major categories of evidence such as environmental factors, politics, strategic relevance, and the economy.

Environmentally speaking, the four major centres, Nisibis, Rhesaina, Hatra, and Singara, lie in a steppe land area that covers a substantial part of North Mesopotamia. The four therefore share a common geographical setting that includes the presence of waterway(s), springs, and arable lands in the immediate proximity of the urban structures. The common ecological features are therefore reflected in their analogous importance in terms of political control. Rome's influence in the Mesopotamian borderland was particularly visible in the area whose nodes were the major urban areas. These acted as key points for the maintenance of imperial control.

The role of these cities as trading points and commercial hubs also affected the economic landscape on a regional scale. Few examples: notwithstanding the seemingly geographic isolation, Hatra played a key role in the traffic of people and goods towards North Mesopotamia (Foietta 2018). Furthermore, after the peace treaty of the

[4] It goes without saying that the flights operating from the B departure point – Adana – were involved in most of the coverage of the Middle East and the Gulf.

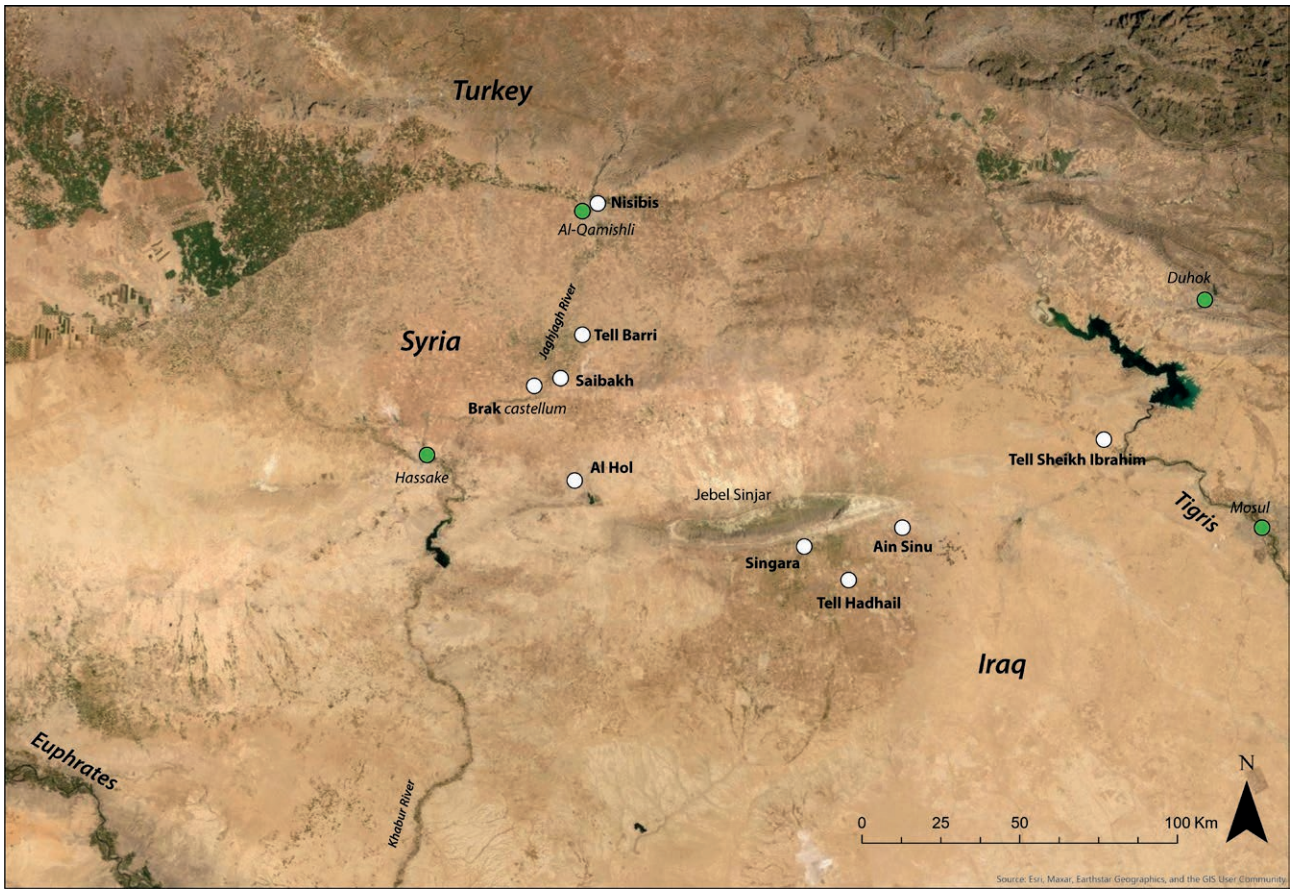

Fig. 1: Spatial extent of North Mesopotamia with major settlements cited in this paper (ESRI basemap / map by the author)

late 3rd c. AD, only Nisibis was granted the permission to establish trade exchanges with Persia, a fact that reflects both the relevance of the city itself and the role that the urban hubs had in the developing economy of the region and of its relationship with distant areas (Palermo 2014; 2019: 228). Prior to the 3rd c. AD, Nisibis and Rhesaina, not too distant from each other, interacted in terms of economic interests, territorial control, and strategy within the political context of Rome's influence in the area. Indeed, both the cities possessed a significant garrison. If Rhesaina connected Nisibis to the westernmost areas of Roman Syria, the regional capital acted as a natural entry for long-distance trade towards Persia and Central Asia.

How is this social and politico-economic importance of urban centres reflected on the ground? How were these centres developed architecturally? How did they interact with the surrounding landscape? These are some of the questions that might arise when dealing with the urban nodes of Roman period Mesopotamia; questions that might find a tentative and preliminary answer through the lens of landscape archaeology. I will therefore present some case studies (cities, small settlements, forts, roads) connected to the period of Rome's interaction in the region and will tentatively analyse their characteristics and features using the remote sensing datasets already described before.

Departing from Singara – perhaps the most well preserved of the Roman period cities of Mesopotamia – I will explore the area to the East, towards the Tigris, and the Upper Khabur basin, to the West and North-West of the city.

Singara. A Fortress City at the Edge of the (Roman) World

The ancient site of Singara (36.328178 N, 41.855121 E) partly overlaps with the Iraqi town of Beled Sinjar (*beled* = Arabic for "town, city", but also Kurdish "Shingal"), in the province of Nineveh, close to Tell Afar and in the foothills of Jebel Sinjar, not far from the modern Syrian–Iraqi border. The city is currently a regional centre predominantly occupied by Kurds and Yazidis to whom the entire region of the Sinjar Mountain is sacred (Açyikildiz 2010). The geographic environment of Singara falls within the classification of steppe-desert, and the city lies on the 250 mm isohyet line. This is an area of elevated climatic uncertainty where yearly rainfall oscillates frequently, causing aridification phenomena that led (and still leads) to social and economic setbacks (Palermo 2021: 247-268). The modern centre is cut in half by a *wadi* coming down from the Jebel Sinjar, and several carsic springs are also scattered around. The remains of the ancient fortress of Singara are still visible in the layout of the modern town of Sinjar. In fact, the northern sector of the circuit walls encloses the modern houses, which exploited part of the fortification and the inner structures of the ancient city. Although some of the still-standing buildings might have been restored, adapted, and modified in later periods (specifically during the early Islamic phases of the city), it is interesting to imagine that these later reconfigurations considered an earlier layout – the largest part of which coincides with the Roman period.

In a CORONA image of 1967 (Mission 1102-1025) one can admire the circuit walls of Singara. They have been quite well preserved within the early modern and contemporary layout of the city. There is no certain evidence for its chronology, but it has been suggested by many (Oates 1968; Scardozzi 2014; Palermo 2019) that the original structure might have been erected at the time of the maximum expansion of the Roman presence in the region, sometime between the early 3rd c. AD and the Diocletian period. Naturally, the entire defensive system has undergone several modifications and transformation through time, and particularly in the 13th c. AD when the city fell within the area controlled by the Atabegs of Mosul (Palermo 2019: 150). The relatively irregular path of the circuit wall is most likely due to the difficulty to adjust masonry and monumental architecture to the rolling landscape in which the city lies, at the southernmost edges of the Jebel Sinjar. In Fig. 2 projecting u-shaped towers are visible at regular intervals, while the possible remains of a fortified – elevated – citadel is also highlighted. There is no indication of a systematic organization of the internal space of the city, nor excavations carried out by David Oates in the 1950s were able to identify any (Oates 1968). One can only assume the spatial organization of Singara on the base of regional comparisons with other well-known and more extensively excavated sites. Dura Europos, on the Middle Euphrates might indeed provide some interesting data in this regard (Baird 2018). As in the case of Dura, Singara was obviously not a uniquely military settlement, and thus the Roman presence had to adjust to the pre-existing urban layout and architecture. If the solution employed at Dura, with the Roman units hosted in the northern edge of the site and (almost) separated by the remaining part of the city by a west-east wall, the same solution cannot be radically and categorically excluded for Singara. However, unlike Dura Europos, surrounded by three side of defensive walls and overlooking the Euphrates from a relatively high cliff to the East, the morphology of the terrain upon which the city of Singara developed offers perhaps a different solution. The citadel, which is visible in the CORONA image to the North of the site, must have hosted administrative building also – and foremost – in pre-Roman times.

Unfortunately, excavations carried out by David Oates and his team did not focus on the citadel, also possibly because it was (and still is) completely covered by modern houses, but systematically explored the gates and some of the defensive towers (Oates 1968: 97-106).

Back to the CORONA image of Singara, it is possible to use the spatial data provided by the satellite imagery to calculate the possible extension of the Roman period city. Indeed, the area enclosed by the city walls does not exceed the 17 hectares, a figure that does not really comply with the definition of Roman period *urban* centre. Also, demographically speaking, the space within the city walls of Singara during the Roman presence in the area must have been quite dense, almost equally distributed between local inhabitants and military personnel (considering the comparison with Dura a viable solution, and there is no doubt to propose an alternative). Several studies have focused on the calculation of demographics and urban demographics particularly, with a substantial number

Fig. 2: CORONA image (Mission 1039-1025, February 1968) of Singara, in Northern Iraq. U-shaped towers (A) and the supposed citadel (B) are visible (map by the author).

of them dedicated to the Roman world.[5] Research conducted within the framework of the Oxford Roman Economy Project shows that an estimated population for nucleated settlements (villages) ranged between 150 and 250 persons per hectare (Witcher 2011: 43). It has also been observed that in Bronze Age Mesopotamia, for example, this range could have varied between 100 and 200 persons per hectare (Postgate 1994; Wilkinson 2003: 39-51). This is largely based on comparative observations of modern rural communities, where building techniques (adobe, mostly) and household components (enlarged families) did not change too much from the ancient times (Kramer 1982). Eventually, by combining a Mediterranean with the Near Eastern model, one can assume that a range of 100-200 persons/ha can be also applied to later periods of Mesopotamian history. And yet, the space within a city was not entirely occupied by private dwellings (public buildings, roads, market squares, and open areas were all part of the urban layout), and for this reason, a lower figure would be much more realistic in determining demographic quantities. The walled area of Singara covers an approximate area of 17 hectares, which means that, considering the low range test parameters, it could have hosted approximately 1,700 inhabitants, a number that seems relatively low for a "city", whereas if one assumes the highest parameter, the population of Singara might raise to circa 3,400, which fits particularly well – proportionally – with the models proposed by Rob Witcher (see above). Starting from the very end of the 2nd c. AD, Singara became the headquarter of the *I Parthica*, one of the two legions deployed in Mesopotamia by Septimius Severus.[6] This evidence suggests that the population could have increased by *at least* by 4.000 units – but higher numbers are more likely. Considering that there is no evidence of an external fort/camp at Singara, one must think that Roman soldiers were hosted within the city walls, following

[5] See the extensive biography on the topic, which is available at: http://oxrep.classics.ox.ac.uk/bibliographies/ancient_city_populations_bibliography/ (Last accessed: December 2022).

[6] *I Parthica* and *III Parthica* were effectively deployed in the region. The *II Parthica*, although created for the eastern campaigns, was headquartered at *Albanum* (Palermo 2019: 81-82). Singara will host the *I Parthica* and the *I Flavia Constatina* during the Sasanian siege of the 344-348 AD (Palermo 2019: 83).

the model that I have already illustrated for Dura Europos. At this point, Singara would have been populated by a potential of ca 6.000 people (lower figure) or, in case of higher estimation, 7.500. These figures are very well within the scale of a mid-to-large settlement in pre-industrial societies, as rightly pointed out by A. Bowman and A. Wilson (2011: 3). Eventually, this increase in population was necessarily tied to a stronger pressure on the potential agricultural catchment area, whose effective exploitability must have represented a great impact on the general economic life of the city.

Indeed, demography – and particularly demography in the ancient world – is considered a key element for the understanding of multiple and complex economic processes (Jongman 2011: 116). Usually, significant intensifications in economic activities during the classical/late antique period in Mesopotamia can be directly correlated with an increase in the size of settlements (Lawrence *et al*. 2016). And indeed, archaeological surveys carried out in the large area from the Upper Khabur basin to the Tigris have demonstrated that the "Age of the Territorial Empires" (the Assyrians, Seleucids, Romans, Parthians, and Sasanians) went hand in hand with a steady intensification of urban and non-urban settlements, despite the natural curves and the inevitable periods of political instability.[7]

Naturally, each major centre of the ancient world was not isolated or detached from its own regional landscape, and if the parameters used to estimate the supposed population of the large centres of Roman Mesopotamia are valid, the next step is to define their possible catchment areas. These zones represent the expendable agricultural potential of each city. A model to calculate the extension of a city's agricultural sustaining area in the fragile landscape of North Mesopotamia has been formulated by the late T. Wilkinson (1994: 483-520). This assumes that a single person eats approximately one hectare's worth of grain or cereals per year (based on a fallowing regime, which can be adapted to the ecological context of North Mesopotamia).[8] According to these figures, the catchment area of Singara, for example, could have extended – at least – for as far as 17 km^2 if one considers a low estimate for its population, or 34 km^2 if using the highest parameters (Fig. 3). The adjoined military population raises these numbers considerably. Unfortunately, no systematic survey has been carried out in the proximity of Singara, and one cannot fully establish to what extent a potential overlapping of catchment areas between the city and the surrounding villages in the countryside might have affected the agricultural and economic scenario. I do believe, however, that – as in the case of early imperial Italy (Horden, Purcell 2000: 270-277) – the landscape of settlements around major cities of Roman Mesopotamia acted within an integrated market economy, rather than being independent and economically isolated.[9] Small and rural sites indeed participated actively in the continuous transaction between agricultural surplus and manufactured goods which defined the urban-rural relationship. There is no apparent reason to believe that this process was not in place also at the very end of the Roman territory, and particularly when the region was firmly in Roman hands, between the end of the 2nd c. and the mid-4th c. AD.

From the Jebel Sinjar to the Tigris

The steppe land that lies between the Singara and Hatra and then towards the Tigris has received attention by the scholars, mostly in connection with the identification of possible tracks linking the Sinjar area to Hatra. Mark Altaweel and Stefan Hauser (2004) analysed the satellite images for this region, rendering an interesting picture that has shed a new light upon the trade connection in this part of North Mesopotamia. I have discussed elsewhere the relevance of the site of Ain Sinu within the context of Roman period Mesopotamia (Palermo 2019: 131-145), here I would like to present spatial data for the area South of the Sinjar and immediately East of Ain

---

[7] On the surveys carried out in the region see, in particular, Wilkinson, Tucker 1995; Wright *et al*. 2002; Morandi Bonacossi, Iamoni 2015; Palermo 2016; Ur *et al*. 2020; 2021; Palermo, de Jong, and Ur 2022.

[8] This model has been based on ethno-archaeological evidence from modern Iraq (Adams 1965). Adams calculated that, excluding the area of Baghdad, the sustaining area for half a million people in the Diyala basin averaged 1.4 hectare per year (Adams 1965: 23 and ff.). See also Kramer 1982: 188-189 for other regional figures.

[9] The strict correlation between major cities and their sustaining countryside in the Near East during the Classical Age has been also postulated for the Seleucia hinterland (van der Spek 2008).

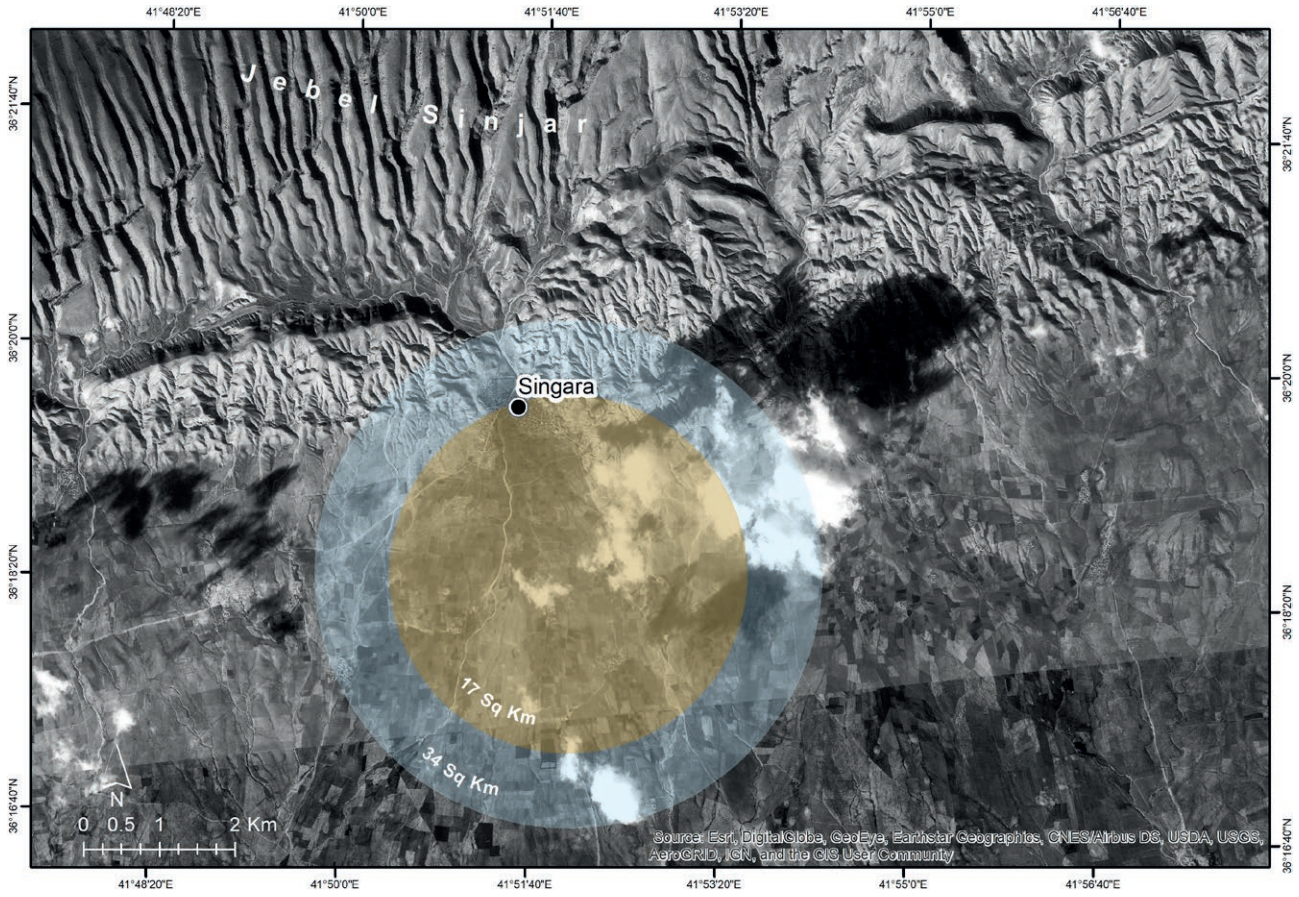

Fig. 3: Possible agricultural catchment area of Roman period Singara. Map by the author.

Sinu, towards the Tigris (Fig. 4). This region is particularly interesting for the understanding of the mobility of people, troops, and goods between the fortified city – as seen with a strong military presence in Roman period – of Singara and Hatra, further to the South. At least two major routes connected Hatra to the Sinjar, one that passes through the site of Tell Hatimiya (south-west of Singara) and another that passes through the site of Tell Hanu (south-east of Singara).

The most interesting site, in this area, is however Tell Hadhail. It is a sub-elliptical large mound, whose relevance was already noted by Ibrahim who briefly surveyed it to notice a consistent and large assemblage of Parthian-Roman material (Ibrahim 1986). The analysis of a 1967 CORONA image (Mission 1102-1025, December 1967) of the site provides some interesting insights (Fig. 5). It shows the presence of several radial linear features departing from gaps in what looks like to be a rampart around the site and that might as well indicate the presence of gates and entrances through the defensive walls. From the southeast part of the site, a couple of tracks are very well visible going towards the direcction of Hatra. Despite the challenge of dating these features, it is nevertheless intriguing to connect Tell Hadhail with Hatra, also considering the abundant Parthian material seemingly collected at the site. Also, based on the datasets from the Peutinger Map, it can be fairly said that Tell Hadhail might also be identified with the prong of *Dicat/Vicat*, marked on the itinerary from Singar (Altaweel, Hauser 2004: 75). In terms of spatial data, comparing the CORONA image of Tell Hadhail with one of the same sites obtained though commercially available datasets (ESRI Base Imagery, in this case) emphasizes once again the importance of declassified satellite data for the remotely driven investigation of Mesopotamia (Fig. 6). As Scardozzi and his team have noted (2014: 60) the same CORONA image from 1967 (Mission 1102-1025) shows traces of what looks like a squared moat that

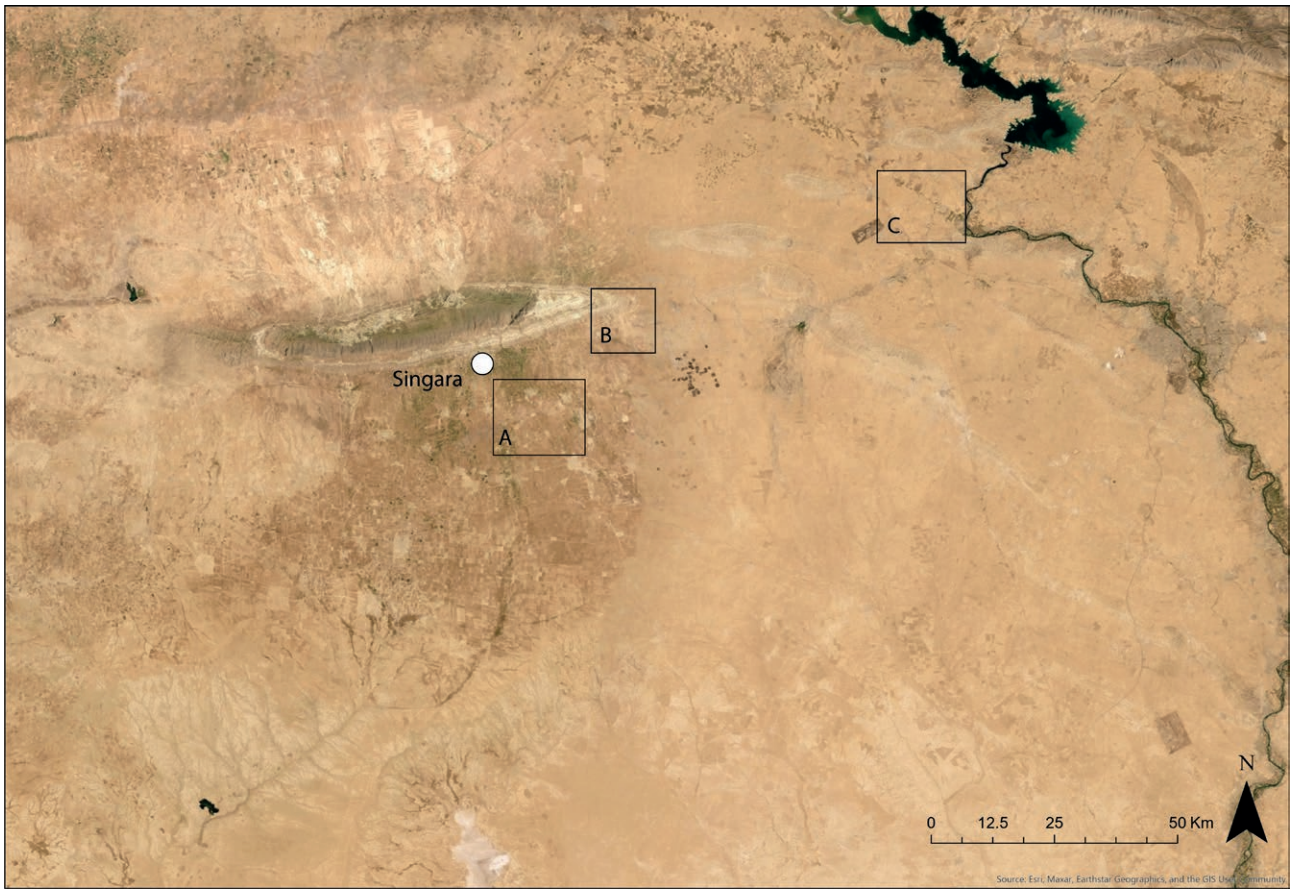

Fig. 4: The area between the Jebel Sinjar and the Tigris in Northern Iraq. The letter-marked blocks indicate the zones of the sites and features discussed in the text. (ESRI basemap / map by the author).

might have taken advantage of a former *wadi* or paleochannels to the West of the site. The comparison, regarding the squared structure, with more recent satellite data (ESRI Basemap) makes once again stand out the relevance of CORONA and declassified imagery to identify small-to-medium scale architectures in the dry landscape of North Mesopotamia. It is not clear what the squared moat would have encircled, but its position not far from what seems to be an important regional site, might also suggest a temporary presence in the area of a small (and seasonally displaced?) detachment of soldiers somewhere in the time of the major expansion of Tell Hadhail.

Further East of Singara lies the site of Ain Sinu (or Ayn Sind'), located not far from the modern tarmac road that connects Beled Sinjar to Tell Afar. I have discussed elsewhere the role and architecture of Ain Sinu (Palermo 2019), whose interpretation still relies on the excavations carried out by David Oates in the late 1950s (Oates 1968). In the interest of a comparative approach with other Roman/Parthian period sites that I will discuss further on in this paper, the *barracks* and the *castellum* of Ain Sinu should be considered as possible examples of military-related structures in the area. From a CORONA image (Mission 1039 – February 1968) the structures of Ain Sinu I and Ain Sinu II are visible with no modern coverage, unlike a relatively recent ESRI imagery where concrete buildings and other disturbance features are scattered over and around the site (Fig. 7). Based on the excavations carried out by David Oates, we are in possession of much more knowledge regarding the spatial organization of the barracks at Ain Sinu I. The fort is one of the largest in the region: it measures 342 x 310 m ca covering an area of approximately 10 hectares. The camp has no corner towers, although possible gate entrances have been identified on the four sides. The internal space featured 12 barracks arranged in two rows. These were constituted by 22

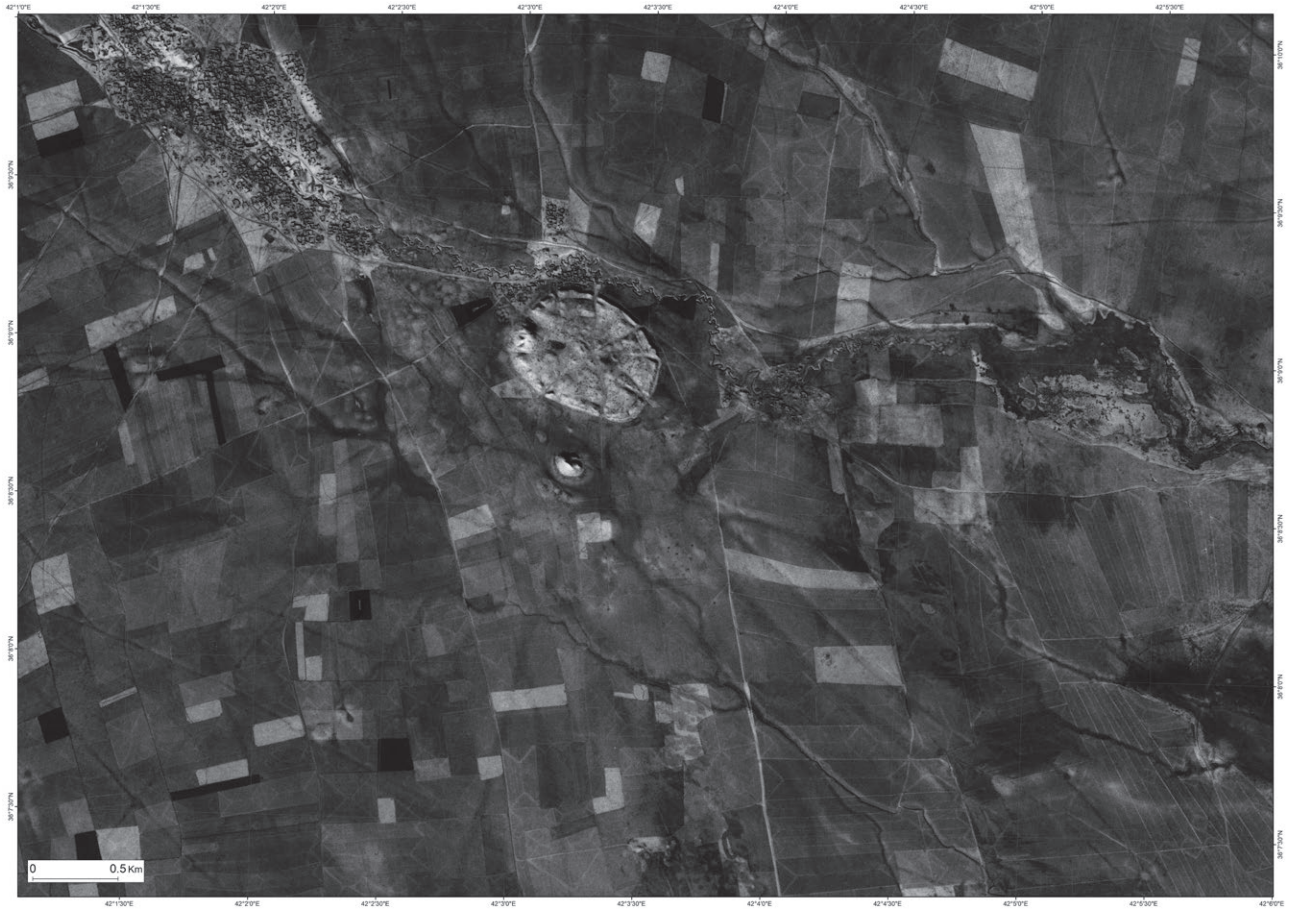

Fig. 5: CORONA image (Mission 1102-1025, December 1967) of the site of Tell Hadhail, South of Singara in Northern Iraq. Map by the author.

double rooms not communicating between them and with each entrance at the opposite end.[10] The remains of AS II, located immediately to the North-East of the barracks are smaller in size and remind of a commanding structure, perhaps the headquarters of the troops' commander stationed in what seems to recall a more proper *castellum*. U-shaped towers are clearly visible in the CORONA image, as well as partly still standing above the ground in the modern commercial shot (ESRI). Chronology for the entire Ain Sinu complex has been determined because of the pottery recovered during the Oates excavation as well as some numismatic evidence. The ceramic horizon of Ain Sinu places the site within the Parthian period sphere of culture for this part of northern Mesopotamia. Distinctive ceramics such as the so-called *Diamonds-stamped pottery* have been found at the site. These have a limited chronology that spans from the early 1st to the 3rd c. AD (Oates 1968: 149 and Appendix A).

The peculiar architecture of the Ain Sinu complex, and especially of AS I, barely fit within the scheme of the Roman-period forts and camps from the Western Mediterranean or central Europe. There is a striking similarity in terms of architecture, size, and other features with one of the dozens of Sasanian-period camps located along the Gorgan Wall in North-western Iran (Rekavandi *et al*. 2007). The most likely interpretation is that the camp was built (and occupied) by a cavalry detachment composed of local people and then, but this remains a speculation, taken by the Sasanians at the beginning of the 3rd c. AD during the successful campaign of Shapur I against the

[10] Oates (1968: 82) interpreted the smaller room as a space for possibly accomodating horses. There is, however, no certain clue about its real function.

Fig. 6: ESRI image of the site of Tell Hadhail in 2021 (ESRI Basemap/ map by the author).

Romans. It is tempting to suggest the adjustment of the structures of Ain Sinu in that period, as the Iranian comparison seems to indicate.

Another interesting example of the application of satellite imagery for the identification of possible Roman period structures in the area comes from further East. It is most likely that from Singara (through Ain Sinu) the major route that cut this part of northern Mesopotamia from West to East reached the Tigris not far from the modern Iraqi town of Tell Afar. Its strategic location in a narrow *wadi* valley between two ridges made the city the gate towards the rivers for caravans and armies. Modern buildings cover a large part of the ancient settlement, but the fortified citadel at the centre of the city speaks for concrete evidence of its past. At Tell Afar, most likely, the route bifurcated. One route went towards Eski Mosul (Balad – perhaps *Ad Flumen Tigrim*) and the Tigris, whereas the other proceeded in a south-east direction, following the southern slope of the Jebel Sheikh Ibrahim. Indeed, circa 20 km south-east of Tell Afar lies the eponymous fort of Tell Sheikh Ibrahim (circa 90 × 85 m = 0.78 hectares). Internal rooms were visible to Kennedy and Riley (1990: 157), but they have since disappeared. However, an internal architectural organization can be seen in a CORONA image (Mission 1102, December 1967) (Fig. 8). As in other cases, there is no certain indication of the chronology. Sir A. Stein, however, suggested that the fort at Sheikh Ibrahim could be identified with an unnamed station on the Peutinger Map in the itinerary towards Hatra (Gregory, Kennedy 1985: 57). The inner layout of the site, as it is visible from space, does not suggest a precise chronological indication and the spatial organization of the badly surviving structures is difficult to read. At the moment, and lacking a proper field observation of the remains, the case of Sheikh Ibrahim rests as one of the many whose precise role in the understanding of the military organization of Roman (and post-Roman? Islamic? – difficult to say) landscape control remains obscure.

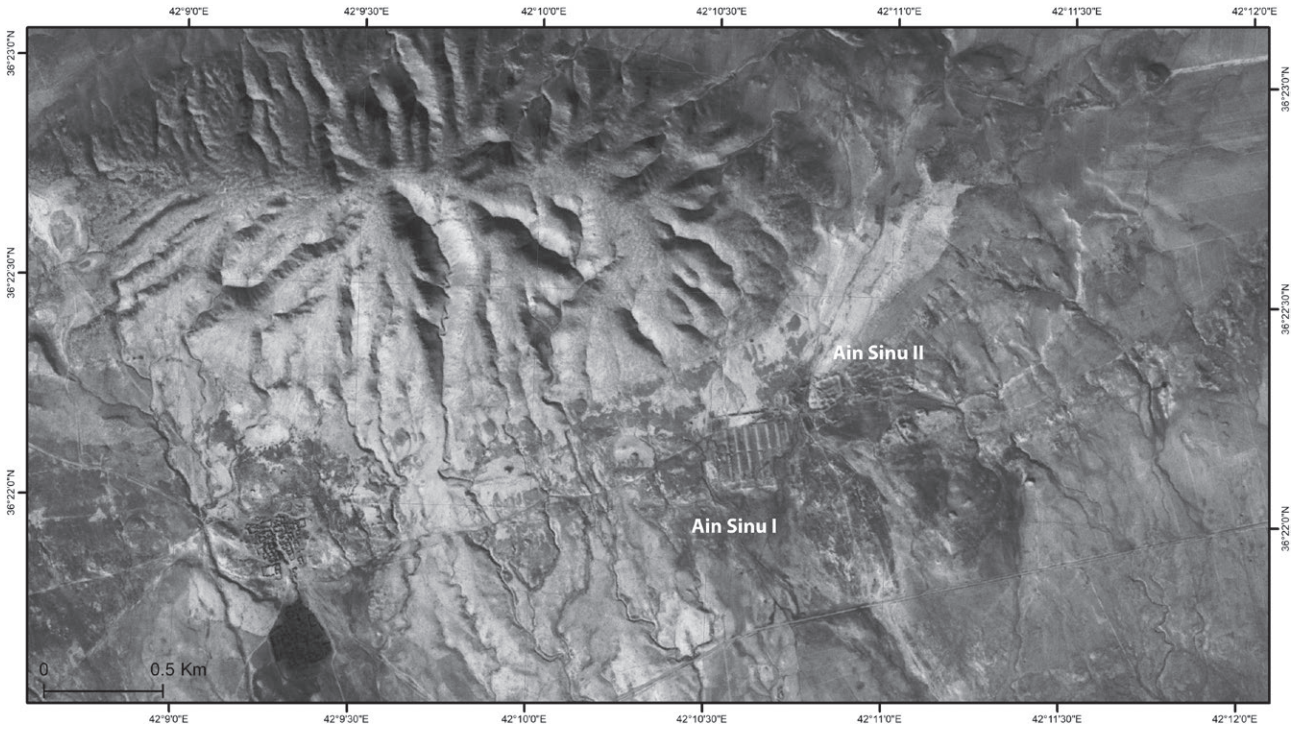

Fig. 7: CORONA image (Mission 1039-1025, February 1968) of the site of Ain Sinu, in Northern Iraq. Map by the author.

The Upper Khabur basin. From Tell Brak to Tell Barri

Besides the Sinjar–Tigris line, another crucial area for the Roman control of Mesopotamia is the Upper Khabur basin and, particularly the area of one of its tributaries, the *wadi* Jaghjagh , which also includes, in its uppermost part, the provincial capital of Nisibis. Forts and several squared structures were already identified, specifically in the lower course of the *wadi* Jaghjagh, by Poidebard, who linked the structures with the Roman army (Poidebard 1934: pl. CXXXIX). Poidebard also suggested the existence of a (micro) regionally important centre at the village of Al-Hol, close to the Khathunyieh lake (the *lacus Beberaci* of the Peutinger Map) (Poidebard 1934: 1818: see also Scardozzi 2014: 46). Sir Aurel Stein, few years after Poidebard, also photographed the settlement at Al-Hol (Kennedy, Riley 1990: 148). Poidebard recognized a fortified place 4 km north of Al-Hol (not too far from the lake, < 10 km) (Poidebard 1934: 157). The importance of this fortified site is related to the fact that it apparently lies along a road arriving directly from *Thannouris*, which marks the second route reaching the lake besides the one passing via Hassan Aga. The site is extremely interesting in terms of architecture. It is formed by a large enclosure that covers almost 6 hectares, and which also includes, within its walls, a second squared fort (80 m per side) in the proximity of the southern side of the larger enclosure. Circa 1 km east of this walled area, a second squared fort is visible (approximately 140 m per side). Both structures are very clearly visible in the CORONA image (Mission 1102, December 1967, see Fig. 9), as well as in commercial satellite pictures, although the recent shots show the inevitable marks of time in terms of architectural preservation. Comparatively speaking, the fort North of Al-Hol is reminiscent of the fortification of Sura, where an early, smaller fort was later enlarged by adjoining to it a much larger walled structure, presumably in the 6th c. AD, and the fortification at Eski Hendek (Algaze *et al.* 2012: 44-45). D. Oates also suggested that the smaller squared structure could be interpreted as a *mansio* (i.e., a small fort) (Oates 1982: 198).

A unique comparison between different sets of declassified data, namely HEXAGON and U2 imagery, supports the discussion regarding the case of two nearby squared structures in the lower Jaghjagh basin. Fig. 10 shows

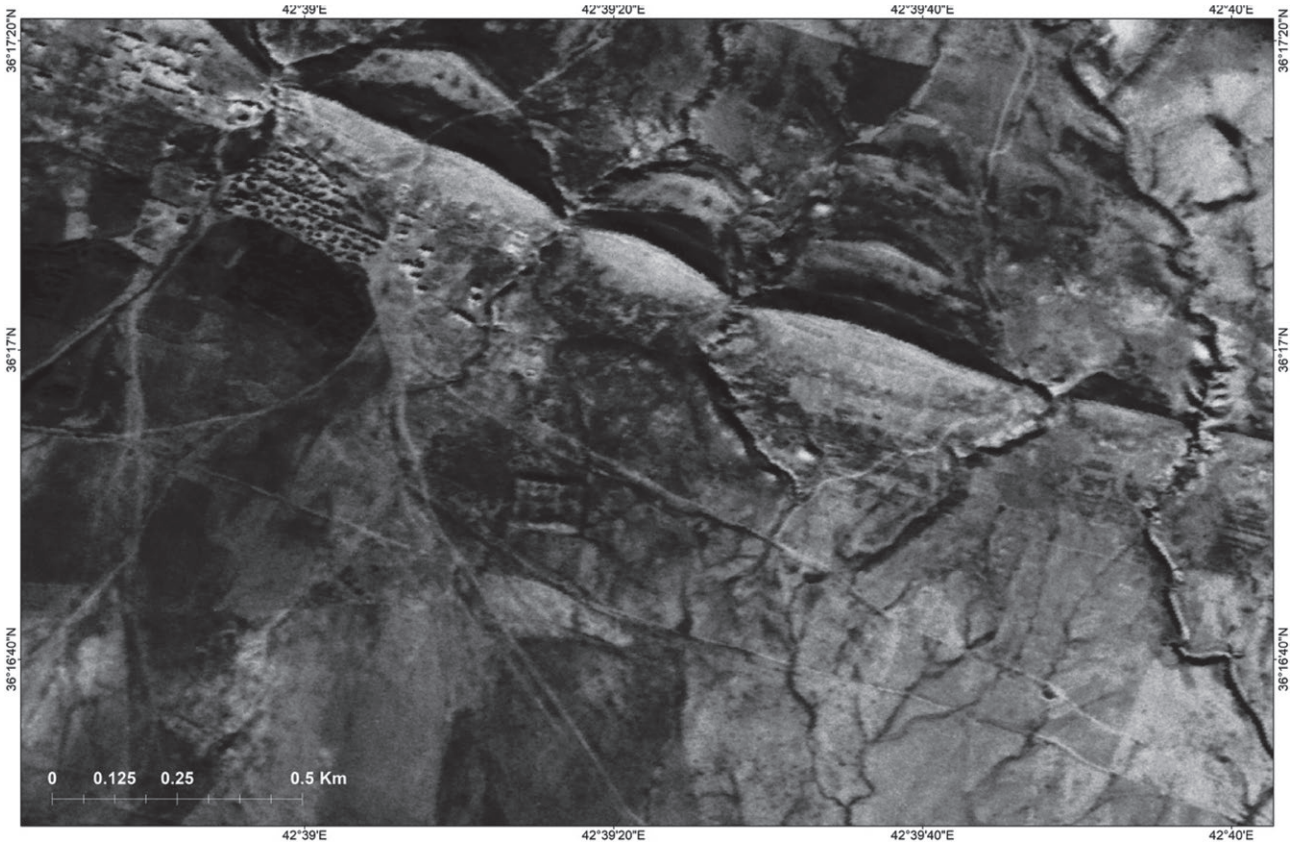

Fig. 8: CORONA image (Mission 1039 -1025, February 1968) of the squared structure of Tell Sheikh Ibrahim.

the overlap of HEXAGON (ref) on the left and U2 (ref) on the right. From the image it is easy to spot the two squared structures (A and B). A is the so-called *castellum* of Tell Brak (Oates, Oates 1990: 226), located ca 400 m from the large pre-classical mound of Tell Brak. The site was noted and the briefly excavated by Poidebard in 1928 who made soundings at the corners and in the middle area of the built space (Poidebard 1934: 144-146). His aerial picture of the structure is also particularly relevant about the possible existence of linear features (trackways and canals) around the site. Poidebard dated the *castellum* to the time of Justinian (6th c. AD) mostly on the base of the architecture, while later visits by David and Joan Oates recovered several Roman period sherds (including a Roman-type lamp) (Oates, Oates 1990: 226). From 2003 to 2006 the Brak Suburban Survey Project carried out intensive on and off-site collection at Brak, mapping both the main mound and the surroundings area (Ur, Kasgaard, Oates 2011). The sherd-collection around the *castellum* yielded a large amount of Abbasid period ceramics, with little or no presence of Roman and post-Roman materials despite the earlier identification by David and Joan Oates (Ur, Kasgaard, Oates 2011: 15). This discrepancy in the datasets might be explained by the fact that a finer-grained chronology of the late-antique materials (often labelled as Roman or post-Roman/Byzantine) collected at the site allowed a more accurate identification as early Abbasid ceramics, whose similarity with 6th and 7th c. pottery (e.g., Byzantine Brittle Ware) might have induced earlier investigators to date the *castellum* to the pre-Abbasid era. This, ultimately, does not necessarily mean that there was no earlier phase at the *castellum*, but its visibility and chronology remain to be fully assessed.

Indeed, the abundant presence of Abbasid period ceramics – which coincided with a period of renewed growth for the nearby site of Tell Brak, certainly speaks for an intense occupational phase of the structure, but it is difficult to say whether the Abbasid occupation was the sole one at the *castellum* or rather a phase of re-occupation of a pre-existing structure.

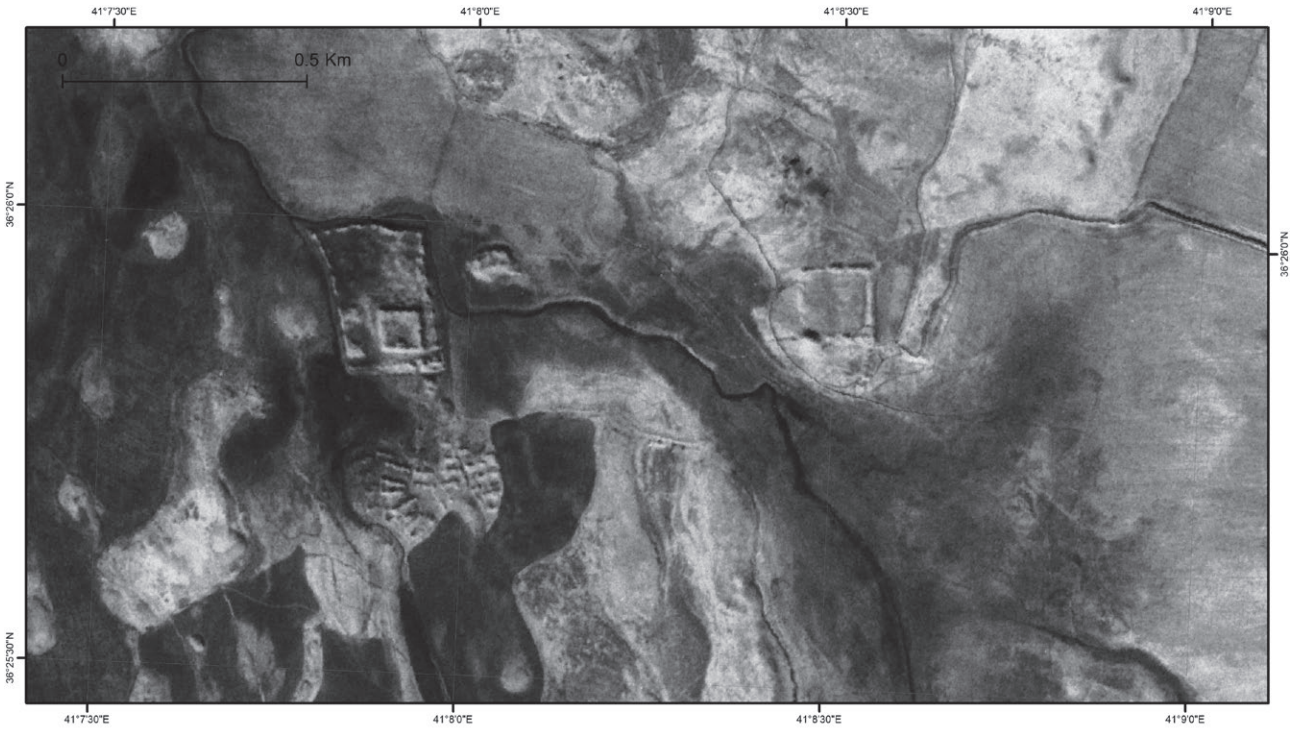

Fig. 9: CORONA image (Mission 1102, December 1967) of two possible forts in close proximity of the modern Syrian village of Al-Hol. Map by the author.

Already Poidebard noted that the structure at Brak was part of a possible wider system of forts in this area of the Jaghjagh river, and indeed the nearby evidence at Saibakh (at the other side of the *wadi*), ca 4 km East of the *castellum* temptingly speaks for a system of forts and camp-like structures in this part of North Mesopotamia. Saibakh is the name of a village located East of the *wadi* Jaghjagh ca 4.5 km from the large mound of Tell Brak, in Northeastern Syria.

The first remote reconnaissance of the possible camp at Saibakh was made by Poidebard. The 1928 aerial picture show a sub-squared site with linear internal divisions, clearly spaced out and seemingly planned. Also, around the site (already then occupied by modern supposedly mudbrick houses) the remains of a moat or a ditch with a possible opening to the East are visible.

A U2 aerial image (September 1959) over the area shows quite clearly what looks like a small, squared camp with internal subdivisions (Fig. 11). The disposition of the modern mudbrick houses suggests the superimposition of the recent buildings to some pre-existing architecture. The built space of modern Saibakh seems to be enclosed by a moat or ditch that recalls the same type of the one already discussed for the Brak *castellum*.

The village of Saibak was briefly visited by David and Joan Oates during their low-resolution and non-systematic reconnaissance of some *Graeco-Roman period* sites in the lower Jaghjagh basin and in close proximity of Tell Brak. Surface collection – performed in a very no-strategic manner- yielded some unspecified Roman period pottery. No further indication of other possible occupational period is given (Oates, Oates 1990).

Further to the East of Tell Brak, and close to the Bronze Age city of Tell Beydar, immediately to the East of the Syrian village of Tell Bati, there is another sub-squared feature – very similar to the remains of Brak and Saibakh. The remains of the structure measure ca 230 x 250 m. In the aerial picture that Poidebard took in 1928, potential internal divisions are visible at Bati, also very similar to the spatial organization of Saibakh and, to a lesser extent, Ain Sinu II. Poidebard himself noted that the linear features visible from the air could have been interpreted as remains of earth embankments for the accommodation of temporary tents (Poidebard 1934: pl. CXXXIX).

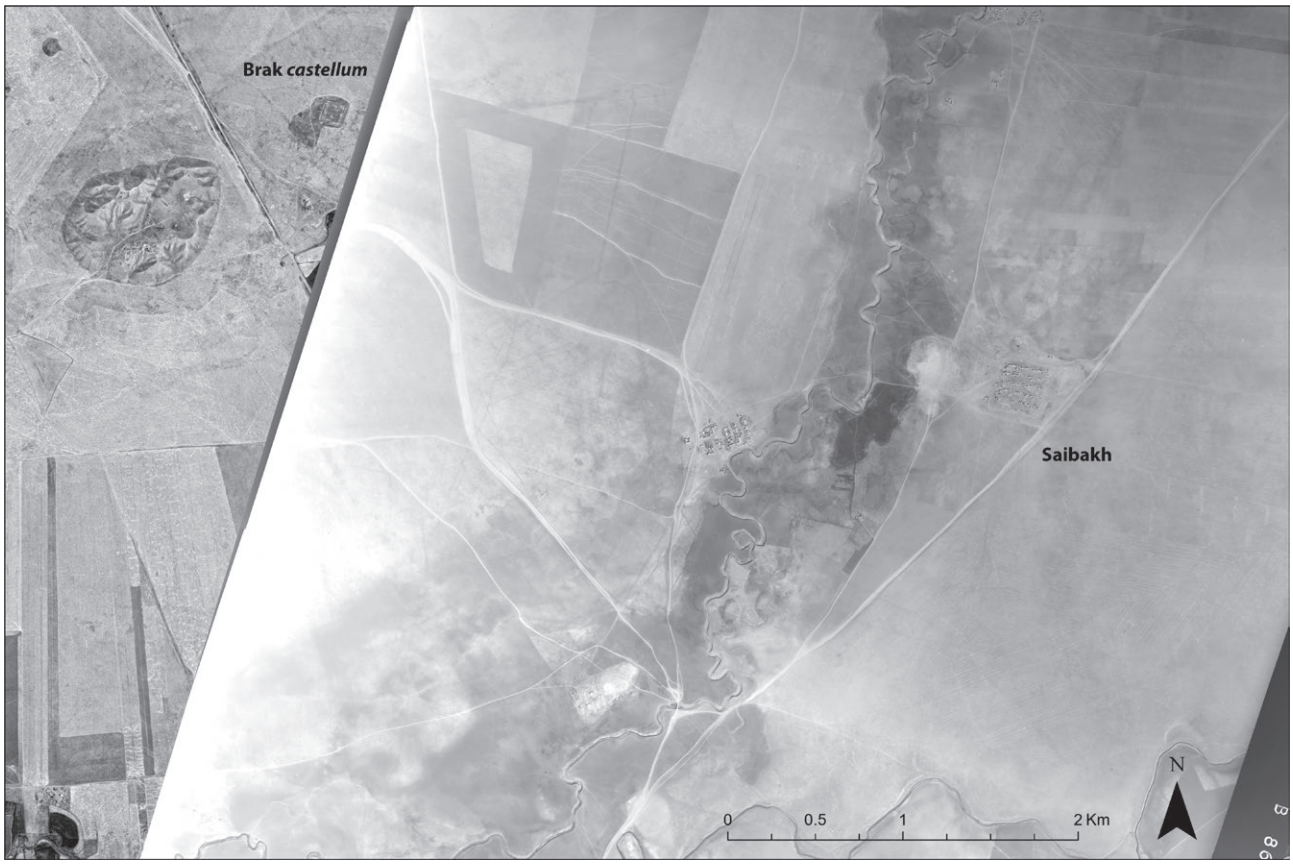

Fig. 10: Comparative image between a HEXAGON image (Mission 1212, 1976) and U2 aerial image (Mission B8638, September 1959) of the so-called *castellum* at Tell Brak and the supposed camp at Saibakh. Map by the author.

The case of the *squared structures* at Saibakh and Tell Brak, are particularly interesting for the scope of this paper, as they allow a proper comparison between three different remote datasets: HEXAGON, U2 aerials, and the recent ESRI Base Imagery. The first thing that strikes the eye is the incredibly high resolution of the U2 records, which provide an unprecedented level of detail for the steppe-like area around the two sites. It is also very peculiar to note now modern houses at Saibakh have been almost precisely superimposed to the potential layout of the barracks (?). HEXAGON and even modern commercially available satellite data do not offer the same resolution of the U2 and yet, in the case of the HEXAGON picture mostly, a large anthropic area is visible to the North of the site, possibly to be put in connection not only with the squared structure, but most likely with the small *tell* located immediately to the West of the modern village.

An additional example of the potential of satellite declassified data for the archaeological research in North Mesopotamia and within the time frame of the Roman period occupation of the region comes from the well-known and thoroughly excavated site of Tell Barri. Tell Barri lies along the eastern bank of the *wadi* Jaghkagh, ca 8 km North of Tell Brak and thus within the same micro region of the Brak *castellum* and the supposed fort at Saibakh. The site has been systematically excavated since the 1980s and the works only suffered a halt due to the political turmoil in the region in 2010 (Pecorella, Salvini 1982; Pecorella 1998; Pierobon Benoit 1998; 2008; Palermo 2019). Explorations at Tell Barri have revealed the long history of the settlement, almost continuously inhabited from the early Bronze Age to the late Islamic period. The Parthian-Roman period (late 2nd c. BC – early 4th c. AD) is particularly well represented with domestic structures, large-scale buildings and the massive defensive wall unearthed on the *tell*, the *acropolis* of the classical town (Palermo 2019 for an overview of the results of the exca-

Fig. 11: U2 image (Mission B8638, September 1959) of the village of Saibakh. Map by the author.

vations at Barri). Despite the extremely interesting results from the site itself, however, no systematic intensive on and off-site survey was never performed. And yet recently the remote analyses of declassified satellite and aerial documents show that the site size was significantly larger than the area interested by the *tell* with an extended lower town topping almost 450 hectares. The measure is based on the potential extension of the anthropogenic soils visible in the imagery (Fig. 12). While it is impossible to securely determined in which historical periods the lower town was occupied and for how long – considering that no artefact-collection was ever carried out – it is tempting to link the occupation of the large area South and East of the *tell* the major historical phases documented by excavation. It is a matter of fact that Tell Barri – *Kahat* in the Iron Age, name unknown in later periods – was a centre of a certain importance in the Parthian and Roman period. Occasional soundings were performed prior to the civil war of Syria in the lower town (Pierobon Benoit 2008), whereas the only relatively-large area excavated off the mound, ad close to the *wadi* Jaghjagh to the South-West of the *tell* – Area M – has yielded a large and architecturally articulated complex with possible administrative and economic functions dated to a period in between the very end of the 1st millennium BC and the 1st millennium AD, namely the Parthian phase (Pierobon Benoit 1998). It is henceforth tempting to relate the architectural anomalies visible in the U2 and HEXAGON pictures to the South and South-East of the *tell* to the later periods of occupation on the site. Indeed, this, extended, signature in satellite and aerial imagery has been proved to be specifically connected with low-density, large, Byzantine-Sasanian settlements in the plain of Erbil, where similar remote-sensing analyses have been carefully ground-truthed (Ur *et al*. 2021). It is difficult to interpret this large and extended anomaly with no ground control, but some hypotheses can be formulated, nevertheless. Fig. 13 shows signatures of what seems to be architectural evidence and open-air spaces (e.g., roads, courtyards, squares, etc.). Possible entrances into the city walls are also marked in the pic-

Fig. 12: U2 image (Mission B1554, January 1960) of the site of Tell Barri, in northeastern Syria. Map by the author.

ture. Interestingly, an 80 x 80 sub-squared structure is visible immediately to the East of the northern slope of the mound. As in the previous cases its chronology and function remain however cloaked in darkness.

CONCLUSIONS

There is no further indication or any proven evidence that all the squared structures widespread in the steppe lands between north-eastern Syria and north-western Iraq can be dated to the Roman (or post-Roman, e.g., Byzantine) period. Most of these structures have only been remotely identified. Some have been surveyed, and only a very small number (such as the already mentioned Brak *castellum*) have been subjected to systematic archaeological investigation. In this context of uncertainty, however, the remote analysis of declassified aerial and satellite data can provide new insights into the comparative approach to many structures (and infrastructures) widespread in Northern Mesopotamia. The examples discussed in the text are only some of the dozens and dozens of similar forts, camps, and barracks that have been built and used in the steppe lands of Syria and Iraq for a quite long period of time. At the current stage of archaeological research on the Roman period eastern borderland it is difficult to suggest both a systematic spatial organization of the landscape or an opportunistic and strongly connected to the events plan regarding the supposed existence of said military structures. It is tempting to propose however – as new trajectories of research – a thorough analysis of the scattered, multiple evidence of squared structures, isolated forts, and possible camps through an accurate remote investigation. I am under the impression that – notwithstanding the difficulty in putting the feet in the ground in some zones of the discussed area – the typological and comparative approach

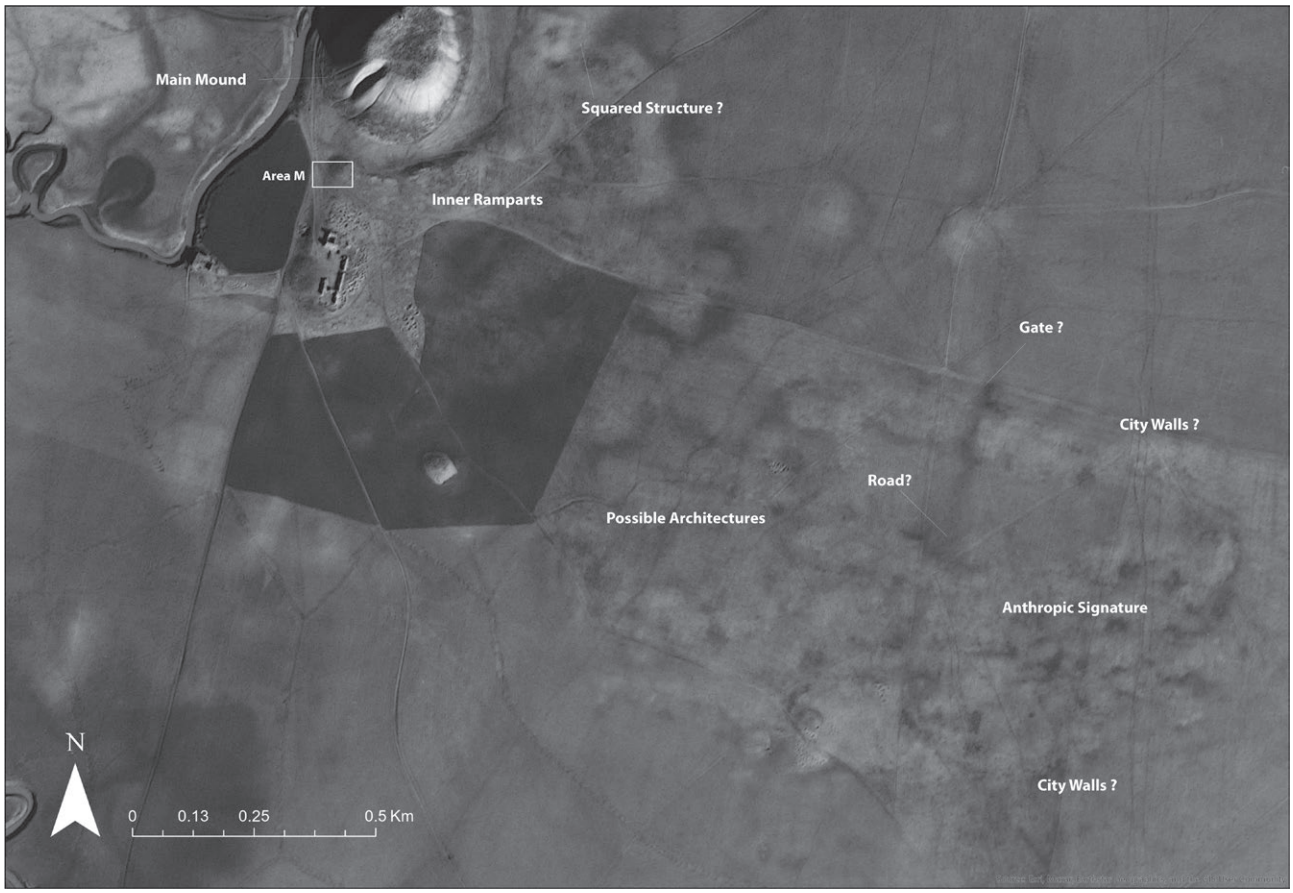

Fig. 13: Possible anthropic features and signatures at Tell Barri. Map by the author.

might indeed lead to new interpretations of the easternmost areas of the Roman world, where the imperial connections and interactions impacted greatly on the daily life of civilian and military communities.

REFERENCES

Açikyildiz, B. 2010, *The Yezidis: The History of a Community, Culture and Religion*, Routledge, London.

Algaze, G., Hammer, E., Parker, B., Breuninger, R., Knudstad, J, 2012, The Tigris-Euphrates Archaeological Reconnaissance Project: Final Report of the Cizre Dam and Cizre-Silopi Plain Survey Area, *Anatolica* 38: 1–115.

Alizadeh, K., Ur, J.A. 2007, Formation and Destruction of Pastoral and Irrigation Landscapes on the Mughan Steppe, North-Western Iran, *Antiquity* 81: 148–160.

Altaweel, M., Hauser, S.R. 2004, Travelling via Hatra: Trade Routes in the Eastern Jazira According to Evidence from Ancient Sources and Modern Satellite Imagery, *Baghdader Mitteilungen* 35: 59-86.

Bates, T.R., 1975, Gramsci and the Theory of Hegemony, *Journal of the History of Ideas* 36 (2): 351-366.

Bidwell, P. 2007, *Roman Forts in Britain*, The History Press, Stroud.

Bowman, A., Wilson, A. (eds.), *Settlement, Urbanization and Population*. *Oxford Studies on the Roman Economy*, Oxford University Press, Oxford.

Breeze, D.J. 1983, *Roman Forts in Britain,* Shire Publications, Aylesbury.

Casana, J. 2020, Global-scale archaeological prospection using CORONA satellite imagery: automated, crowd-sourced, and expert-led approaches, *Journal of Field Archaeology* 45: 89–100.

Casana, J., Cothern, J. 2008, Stereo analysis, DEM extraction and orthorectification of corona satellite imagery: archaeological applications from the Near East, *Antiquity* 82: 732–49.

Casana, J., Laugier, E. 2017, Satellite imagery-based monitoring of archaeological site damage in the Syrian civil war, *PLoS ONE* 12, e0188589

Edwell, P. 2008. *Between Rome and Persia: The Middle Euphrates, Mesopotamia and Palmyra under Roman Control,* Routledge, London-New York.

Fisher, G. (ed.). 2016. *Arabs and Empires before Islam*, Oxford University Press: Oxford.

Foietta, E. 2018, *Hatra. Il territorio e l'urbanistica*, Archaeopress, Oxford.

Franconi, T. 2020, Hydrological Change and Settlement Dislocation along the Later Roman Rhine, in P. Cimadono, R. Palermo, R. Pappalardo, R. Pierobon Benoit (eds.), *Before-After. Transformation, Change, and Abandonment in the Roman and Late Antique Mediterranean*, Archaeopress, Oxford, 35-50.

Gregory, S., Kennedy, D. 1985, *Sir Aurel Stein's 'Limes Report*, BAR International Series 272, Archaeopress, Oxford.

Hammer, E., FitzPatrick, M., Ur, J.A. 2022, Succeeding CORONA: declassified HEXAGON intelligence imagery for archaeological and historical research, *Antiquity*, 1-17. doi:10.15184/aqy.2022.22.

Hammer, E., Ur, J.A. 2019, Near Eastern landscapes and declassified U2 aerial imagery, *Advances in Archaeological Practice: a Journal of the Society for American Archaeology* 7: 107–26.

Horden, P., Purcell, N. 2000, *The Corrupting Sea. A Study of Mediterranean History*. Wiley: London.

Hritz, C. 2014, Contributions of GIS and Satellite-Based Remote Sensing to Landscape Archaeology in the Middle East, *Journal of Archaeological Research* 22: 229–276.

Ibrahim, J.K. 1981. *New Evidence for Settlement in the Jazirah in the Pre-Islamic Period, with Special Reference to Hatra and Jaddalah*. PhD dissertation, UCL, London.

Jongmam, W. 2011, Archaeology, Demography, and the Economic Growth, in Bowman, A., Wilson, A. (eds.), *Quantifying the Roman Economy. Methods and Problems*, Oxford Studies on the Roman Economy, Oxford: 115-126.

Kennedy, D.L, Riley, D. 1990, *Rome's Desert Frontier from the Air*, Routledge, London.

Kramer, C. 1982, *Village Ethnoarchaeology. Rural Iran in Archaeological Perspective*, Cambridge University Press: Cambridge

Lawrence, D., Philip, G., Hunt, H., Snape-Kennedy, L., Wilkinson, T.J. 2016, Long Term Population, City Size and Climate Trends in the Fertile Crescent: A First Approximation, *PLoS ONE*, 11(3): e0157863. https://doi.org/10.1371/journal.pone.0157863

Millar, F. 1993, *The Roman Near East. 31 BC – 337 AD*, Harvard University Press, Cambridge, MA.

Oates, D. 1968, *Studies in the Ancient History of Northern Iraq*, Oxford University Press, Oxford.

Oates, D., Oates, J. 1959, Ain Sinu: A Roman Frontier Post in Northern Iraq, *Iraq*, 21(2): 207–242.

Oates, D., Oates, J. 1990, Aspects of Hellenistic and Roman Settlement in the Khabur Basin. In P. Matthiae, M.N. van Loon, H. Weiss (eds.), *Resurrecting the Past: A Joint Tribute to Adnan Bounni*, NINO Press, Leiden: 227–248.

Oder, F.C.E, Fitzpatrick, J., Worthman, P.E. 1992, *The HEXAGON story*. Chantilly (VA): Center for the Study of National Reconnaissance.

Palermo, R. 2014, Nisibis, Capital of the Province of Mesopotamia: Some Historical and Archaeological Perspectives, *Journal of Roman Archaeology*, 27: 456–471.

Palermo, R. 2019, *On the Edge of Empires. North Mesopotamia during the Roman Period,* Routledge, London-New York.

Palermo, R. 2021. Climatic Variations and Imperial Landscapes in Northern Mesopotamia. From the Fall of Assyrian to the Parthian-Roman Period, *Egitto e Vicino Oriente* 44: 247-268.

Palermo, R., de Jong, L., Ur, J.A. 2022, Hellenistic Landscapes and Seleucid Control in Mesopotamia. The View from the Erbil Plain in North Iraq, *American Journal of Archaeology* 126 (3): 80-97.

Parcak, S., Gathings, D., Childs, C., Mumford, G., Cline, E. 2016, Satellite evidence of archaeological site looting in Egypt: 2002–2013, *Antiquity* 90: 188–205.

Pecorella, P.E. (ed.). 1998. *Tell Barri/Kahat 2. Relazione sulle campagne 1980-1993 a Tell Barri/Kahat, nel bacino del Habur (Siria)*. Documenta Asiana V, CNR Istituto per gli studi Micenei ed Egeo-Anatolici, Roma.

Pecorella, P.E. & Salvini, M. (with contributions by Biscione, R., Ferioli, P., Fiandra, E., Parmegiani, N., Venco Ricciardi, R., Scerrato. U., Sorda, S., Ventrone Vassallo, G.) 1982, *Tell Barri/Kahat 1. Relazione Preliminare sulle campagne 1980–1981 a Tell Barri nel bacino del Habur*, CNR Istituto per gli studi Micenei ed Egeo-Anatolici, Roma.

Pierobon Benoit, R. (ed.). 2008. *Tell Barri: storia di un insediamento antico tra Oriente e Occidente*, Macchiaroli, Naples.

Pierobon Benoit, R. 1998, Dall'Ellenismo al Medio Evo: dati e problemi a Tell Barri, in P.E. Pecorella (ed.), *Tell Barri/Kahat 2, Relazione sulle campagne 1980–1993 a Tell Barri/Kahat, nel bacino del Habur (Siria),* Documenta Asiana V, CNR Istituto per gli studi Micenei ed Egeo-Anatolici, Roma, 199–256.

Poidebard, A. 1934, *La Trace de Rome dans le Désert de Syrie. Le Limes de Trajan à la Conquête Arabe*, Geuthner, Paris.

Postgate, N. 1994, How Many Sumerians per Hectare? Probing the Anatomy of an Early City, *Cambridge Archaeology Journal* 4: 47-65.

Rekavandi, O.H., Sauer, E.W., Wilkinson, T., Safari Tamak, E., Ainslie, R., Mahmoudi, M., Griffiths, S., Ershadi, M., Jansen Van Rensburg, J., Fattahi, M., Ratcliffe, J., Nokandeh, J., Nazifi, A., Thomas, R., Gale, R., Hoffmann, B. 2007, An Imperial Frontier of the Sasanian Empire: Further Fieldwork at the Great Wall of Gorgan, *Iran*, 45: 95–136

Scardozzi, G. 2014, *Il limes orientale tra Siria e Iraq. Dalle fotografie aeree di Padre Antoine Poidebard e Sir Aurel Stein alle immagini satellitari "storiche" e recenti*, Archeologia Aerea (Numero Monografico), 8, Lecce.

Sommer, M. 2005, *Roms Orientalische Steppengrenze. Palmyra – Edessa – Dura-Europos – Hatra*, Franz Steiner Verlag: Stuttgart.

Stone, E. 2008, Patterns of looting in southern Iraq, *Antiquity* 82: 125-138.

Talbert, R.J.A, 2010, *Rome's World: The Peutinger Map Reconsidered* Cambridge University Press, Cambridge.

Ur, J.A. 2003, CORONA satellite photography and ancient road networks: a northern Mesopotamian case study, *Antiquity* 77: 102–15.

Ur, J.A., de Jong L., Giraud, J., Osborne, J.F., MacGinnis, J. 2013, Ancient Cities and Landscapes in the Kurdistan Region of Iraq: The Erbil Plain Archaeological Survey 2012 Season, *Iraq* 75: 89-117.

Ur, J.A., N. Babakr, R. Palermo, P. Creamer, M. Soroush, S. Ramand, K. Nováček 2021, The Erbil Plain Ar- chaeological Survey: Preliminary Results, 2012–2018, *Iraq* 83: 205–243 .

Ur, J.A., Reade, J. 2015, The hydraulic landscape of Nimrud, *Mesopotamia* 50: 25–51.

Vermeulen, F., Sas, K., Dhaeze, W. 2004, *Archaeology in Confrontation: Aspects of Roman Military Presence in the Northwest. Studies in Honour of Prof. Em. Hugo Thoen*, Archaeological Reports Gent University, Gent.

Wamser, L. 2000. *Die Römer zwischen Alpen und Nordmeer: zivilisatorisches Erbe Eine europischen Militärmacht*, Philip von Zabern Verlag, Munich.

Wilkinson, T.J. 1994, The structure and dynamics of dry-farming states in upper Mesopotamia*, Current Anthropology*, 35(5): 483–520.

Wilkinson, T.J. 2003, *Archaeological Landscapes of the Near East*, Arizona University Press, Phoenix.

Witcher, R. 2011, Missing Persons? Models of Mediterranean Regional Survey and Ancient Populations, in Bowman, A.,Wilson, A. (eds.), *Settlement, Urbanization and Population*. *Oxford Studies on the Roman Economy*, Oxford University Press, Oxford 36-75.