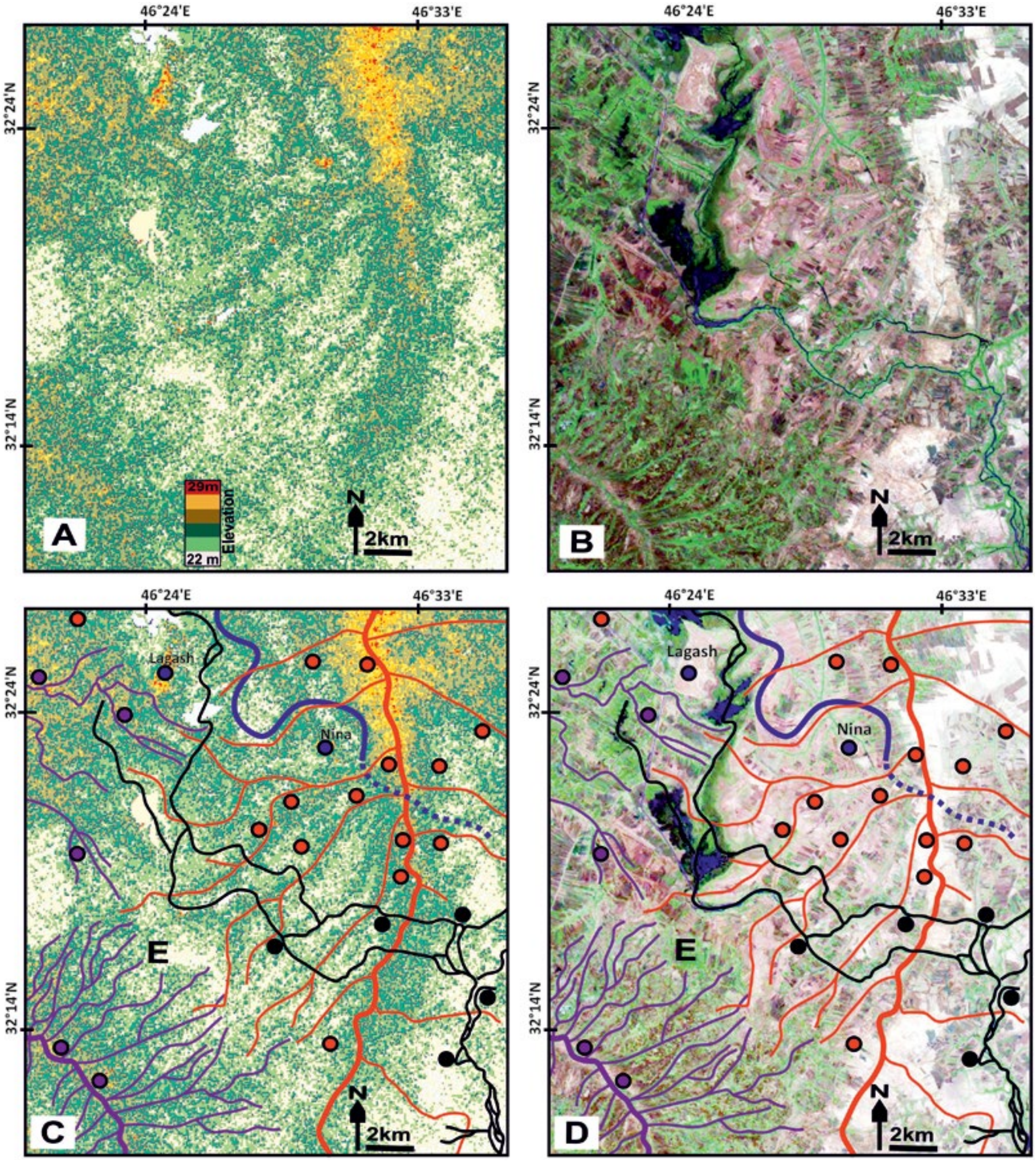
New Agendas in Remote Sensing and Landscape Archaeology in the Near East

Studies in Honour of Tony J. Wilkinson



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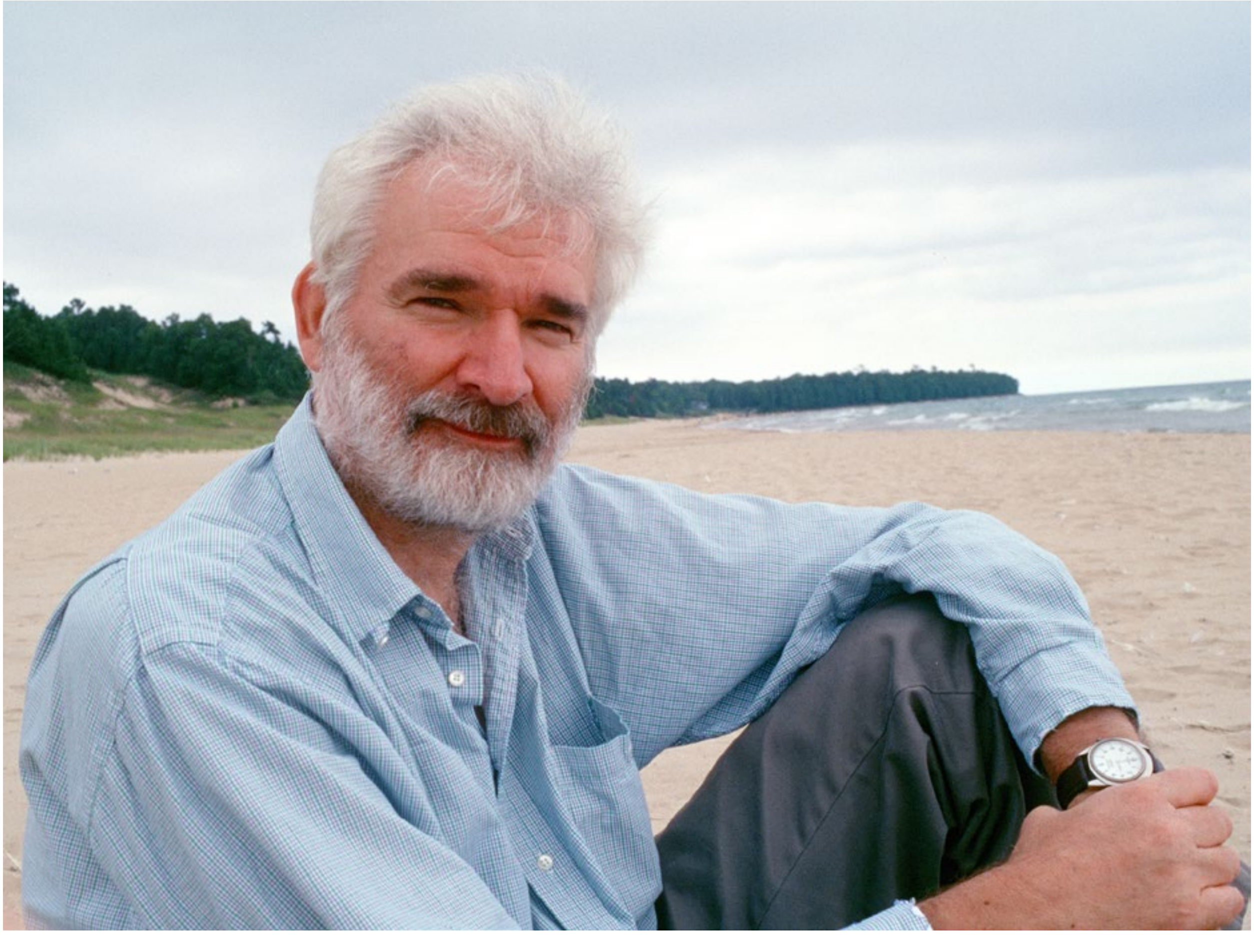
Cover illustration: Palaeochannels and archaeological sites north of Nasiriya, Iraq. A. SRTM image B. Landsat Image C. Features visible on SRTM D. Features visible on Landsat. For full explanation see Chapter 18



Tony J. Wilkinson
14 August 1948 - 25 December 2014

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Preface

Eleanor Barbanes Wilkinson

This volume of collected papers has been produced in honour of Tony Wilkinson (T. J.), who was Professor of Archaeology at Durham University from 2006 until his death on 25 December 2014. Many of the papers in this book were presented at a workshop, organised by Mark Altaweel, Dan Lawrence and myself, at the annual conference of the British Association of Near Eastern Archaeologists (BANEA) at the University of Reading, held on January 10th, 2014. At that time, Tony had been active in archaeology for almost 45 years, and his career had included fieldwork in Britain as well as the Near East (see French 2014 for a summary of Tony's archaeological work in Britain). Tony's 65th birthday was fast approaching, and as we knew then that Reading would likely be his last BANEA conference that milestone provided a convenient focus for celebrating the enormous impact Tony had had upon Near Eastern archaeology. The dialogue initiated in the BANEA workshop is continued and enlarged in this publication. Though this volume is commemorative in concept, the workshop was intended to explore emerging agendas in remote sensing and the ways in which innovative tools, techniques and theoretical approaches can be applied to resolve challenges within the framework of landscape archaeology. Following the example set by Tony in his own career, the authors collectively demonstrate the importance of an interdisciplinary approach for understanding the impact of human activity on shaping the landscape and, conversely, the profound effect that landscape has on sociocultural development.

Tony was a true pioneer in remote sensing applications in archaeology, and the theme of this volume highlights that aspect of his research. Through his creation of the CAMEL (Centre for the Archaeology of the Middle East Landscape) lab at the Oriental Institute in Chicago during the 1990s and his subsequent establishment of Durham University's Informatics Lab, Tony built up a large cohort of researchers who are applying similar techniques of remote sensing to answer research questions in archaeology. Much of the research in this book emanates directly from ideas and techniques which were originally incubated under Tony's creative oversight in the collegial and democratic environments of those two remote sensing labs. Many of the authors in this volume have benefitted from time spent in one of these two research centres, or have utilised data generated within them. In general, contributions were invited from practitioners of regional survey who are actively exploring archaeological issues in the Near East on a broad scale, addressing archaeological landscape contexts and issues beyond a single site, as did Tony himself.

In addition to papers from colleagues who were leading major research projects with Tony (Gibson, Philip, Sauer), the content in this volume includes work from a number of archaeologists who are establishing groundbreaking new trajectories in the field, whose work Tony followed with great interest (Iamoni, Kaptijn, Morandi, Pournelle, Rey, Stone). In the period leading up to the BANEA session, Tony held a leading role in five major projects, including the Fragile Crescent Project, Modelling Ancient Settlement Systems (MASS), Land of Carchemish, Persia and its Neighbours, and the Tripillya Project. Regionally, these projects encompass Iran, Iraq, Syria, the Levant, the Caucasus and Eastern Europe. For the sake of thematic cohesion, the regional parameters of this volume have been limited to projects within greater Mesopotamia, although this means Tony's significant work in Arabia (see Kennet 2015) and Tripillya Project have been omitted. A number of papers in this volume have been contributed by some of Tony's students at Durham University and the University of Edinburgh who were at the time approaching, or had recently completed, their PhDs (Bradbury, Brown, Cunliffe, de Gruchy, Hopper, Jotheri, Lawrence, Rattenborg, Rayne, Smith), as well as former University of Chicago students, now academics themselves, whose research is taking the field in new directions (Altaweel, Casana, Hritz). Certainly, one of the most enduring features of Tony's legacy will be the fact that he launched an impressive generation of scholars now forging unchartered intellectual pathways and exploring new agendas in regional survey through the application of geospatial technologies.

In many ways, Tony's entire approach to the landscape was shaped by his childhood in England, spent walking, fishing, and generally wandering happily within the green and open landscapes of Essex and Wiltshire. As a teenager, he would often ferry across to Ireland or hike up through the wilds of Scotland, spurred on by some particularly beguiling bit of landscape depicted on an ordinance survey map. His undergraduate thesis dealt with the sequential development of the upper Thames River system, revealing an early awareness of the need to integrate water and climate into any reckoning of the archaeological landscape. In the UK, where public right of access to the countryside remains a staunchly defended privilege for everyone, the close association between people and the landscape has deep historical resonance, and this constant engagement with the British countryside seems to have shaped Tony's personality as much as it did his career. In preparing for any trip, either across the globe or across town, he always began by looking at a map of the place, preferably one with topographic contours. He resisted using a GPS in our car; he was a superb navigator, and anyway he considered map reading to be a necessary skill, not to mention an enjoyable one.

As Mac Gibson mentions in his Introduction to this volume, to walk or drive though any landscape with Tony was truly wonderful. Whether in Iraq, Northumbria, or on the streets of Chicago, to share Tony's experience of any outdoor environment was to perceive the world in a way that was always thought provoking, but also frequently hilarious. He had a lovely sense of humour which, combined with his passion for unexplored places and an impressive indifference to the challenges of travelling in far-flung places, guaranteed us a life filled with adventure, friends and purpose. Those of us who were fortunate enough to have worked with Tony in the field know that his insights and observations, often delivered quite casually, were uniquely perceptive and often quite profound. He gave excellent advice. A good friend of Tony's once said of him that he wore his wisdom lightly, and it is true that it was almost impossible not to accept his side of any argument, since it was usually backed up by compelling evidence, and never delivered with arrogance or condescension. Tony achieved a tremendous amount in his brief life, and he has blazed a brilliant trail for others to follow. A student of his once observed that Tony's brilliance wasn't only that he taught archaeology well; it was that he taught people *how to be* as an archaeologist. No doubt everyone who knew Tony would agree with her.

As a mentor, Tony was a magnetic force. His students and colleagues relied upon his boundless enthusiasm and generosity, and he took real pleasure in others' success. He had a unique way of being both confident and self-deprecating at the same time, a quality which attracted many and endeared him to everyone he met. He was a rock of dependability, a perpetual optimist, and just a good soul. Tony and I were married in 1995, and it was my joy and privilege to walk beside him every day for almost 25 years. Though not a landscape specialist, I am an archaeologist and I worked with Tony in Syria, Turkey, Yemen, and Morocco. Writing both as Tony's wife and as his colleague, I can think of no archaeologist more worthy of emulation and no person in Near Eastern archaeology more deserving of the honour offered here by the eminent scholars who have joined together in this publication. This collection of new research opens up an exciting discourse in remote sensing and landscape archaeology, and it is a substantive and fitting commemoration of Tony's long and distinguished career.

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Introduction

McGuire Gibson

Tony Wilkinson transformed, in fundamental ways, our view of Near Eastern landscapes, and therefore of ancient society and economy. With his rare combination of a keen intellect, superior management skills, and an ability to find enjoyment not only in his work but also in good company, he was able to adapt to a great variety of situations. His archaeological fieldwork included innovative projects in Canada, Britain, Greece, Iraq, Syria, Yemen, Oman, Saudi Arabia, Lebanon, Turkey, Morocco, and Iran. This record is astonishing, given that survey can too easily be taken for espionage, and it is a mark of Tony's diplomatic skills, as well as the seriousness with which he was viewed by the authorities in those countries that he was able to accomplish so much. He had an ability to work with anyone, to truly collaborate with scholars in those countries and other foreign researchers working there, as well as training a generation of students to carry on the work. He was a model in publishing his results in a timely and comprehensible way, and was able to envisage new approaches to our field, such as agent-based modelling, and to fashion projects to address the issues involved.

But Tony would have been the first to say that, although he transformed the field of landscape study, he stood in a long line of innovators who made his work possible. For the Near East, the roots of landscape study are ancient, with some of the earliest attempts at mapping found on clay tablets, and with Greek and other ancient writers like Xenophon describing what they witnessed. Arab geographers (Le Strange 1895) added detail, often on the basis of second-hand accounts, which can be assessed for veracity only after you have made a study on the ground.[1]

As early as the 17th Century, European travellers, passing through Syria and Iraq, often on their way to or from India, published valuable accounts. And diplomats and representatives of British or French treading companies resident in Aleppo, Damascus, Mosul, Baghdad and Basra often described the areas in which they lived. But the beginning of serious work on the Iraqi landscape has to be assigned to Claudius James Rich, who studied definitively located Babylon (Rich 1822) and made detailed maps of portions of Iraq and Iran in the early 1800s.

Although done for strategic and commercial purposes related to finding a quicker way to India, the attempt in 1835–37 by Francis R. Chesney (1850; 1868; Guest 1992) to prove the navigability of the Euphrates was a milestone in regional geography. Chesney transported two steamboats in pieces from England to the Levant coast and then to the Tigris, where they were assembled. One boat foundered, but the other made it with difficulty to Basra. His team included cartographers and naturalists, and one of the results was the detailed mapping of the area bordering both banks of the river.

The Bombay government sent British military officers to Iraq throughout the 1840s and 1850s, with the purpose of mapping as much of the country as possible. James Felix Jones created the first good plan of Nineveh and surveyed large parts of Assyria, as well as other areas along the Tigris. T. K. Lynch, W. B. Selby, W. Bewsher, and C. Collingwood mapped most of southern Iraq, but their results were not published until the German geographer, Heinrich Kiepert (1883) combined them with maps by French scholars, such as J. Oppert (1863), who were also beginning to do surveys. The Kiepert map is an invaluable depiction of the state of the landscape of southern Iraq, with its extensive deserts and marshes dotted with hundreds of tells and huge, dead Islamic canals.

In the early 1850s, A. H. Layard (1853) and W. K. Loftus (1857) made forays into the desert of the south, leaving accounts of conditions and the exploration of sites in the area. Much later, at the turn of the century, Koldewey and Andrae, as an adjunct to their excavations at Surghul (Nina) and Fara (Shuruppak), made a short survey locating major sites down to and including the Lagash area (Andrae 1902; Koldewey 1997). More systematic and larger was another German project in 1907–08, the mapping of Islamic canals and sites in Syria and Iraq, especially the mapping of the Nil Canal, by F. Sarre and P. T. Herzfeld (Sarre and Herzfeld 1911–20). This work was a major step in survey for archaeological/historical purposes.

Tied to survey is aerial observation and photography. Armies had used balloons to observe military operations

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[1] When doing my survey around Kish, I found that only Ibn Khordadhbeh, among the five Arab geographers who described the area, had actually been there, as was made clear by details he gave of the Nil Canal, its settlements, and the offtakes from it.

since the French began the practice at the Battle of Fleurus in 1794. Balloons came into widespread use in battle during the American Civil War of 1861 to 1865. Nader took the first photographs from a balloon over Paris in 1858, and kite photography was pioneered by E. D. Archibald in Britain in 1882, but it was with the introduction of the airplane during the First World War (1914–18) that aerial photography came into its own. Allenby, in 1918 in Palestine, is given credit for ordering the air wing to use photographs to correct maps of Turkish positions, but there are a good number of maps of Iraq, made with air photography, that date to about the same time. The British in the 1920s carried out ground surveys of the entire country of Iraq, and it is those maps that still served as the cartography of the country until the introduction of satellite imagery.[2]

Not far behind the military in the early use of aerial photography were the archaeologists and epigraphers. In the early 1920s, James Henry Breasted took photos of Egyptian sites from RAF planes shortly before the French Jesuit aviator, Antoine Poidebard, began his systematic recording of the remains of the Roman *limes* and dozens of sites across Syria (e.g. Poidebard 1934). Aurel Stein also used aerial photography in his research. But the most impressive aerial project is arguably Erich Schmidt's documenting of hundreds of sites in Iran during the 1930s (Schmidt 1940).

The first real systematic archaeological ground survey in the Near East was, as far as I can determine, that of Thorkild Jacobsen, who began to map and collect pottery on tells in the Diyala region around the four major sites being excavated by the Oriental Institute. His research aimed to create a history of settlement based on the notion that all sites had to be located along the rivers and canals in that area, and that the pottery found on the surface would date the occupations. In 1936, Robert J. Braidwood, as a graduate student on Chicago's Amuq expedition (Director, Calvin McEwan), carried out a systematic collection and mapping of sites in that area, resulting in his doctorate and a groundbreaking book. In Northern Iraq and Eastern Syria, British archaeologists, e.g. Max Mallowan and Seton Lloyd, and later David Oates, were conducting surveys of sites preparatory to, or as an adjunct to, major excavations.

The development of archaeological survey techniques in the Near East was stimulated by survey work in the Americas, most notably by A. L. Kroeber and others in Peru, beginning in the early 1920s. G. R. Willey's Viru Valley Project in the years immediately following the 2nd World War (Willey 1953) brought a greater degree of rigor to the process that was emulated by archaeologists, most notably Robert McC. Adams in the Near East.

Adams, of course, is a key figure in settlement archaeology, with his work in Iraq, Iran,[3] Saudi Arabia, and Mexico. His greatest contribution was made in southern Iraq, where, from 1957 to 1975, he put on the map more than 3000 sites. His initial work, while still a graduate student, was a survey of Akkad (Adams 1972), followed closely by the survey of the Diyala Region in 1957–58, which was part of a larger project led by T. Jacobsen and F. Safar (Jacobsen 1958; Jacobsen and Adams 1958; 1965). In that project, the multi-disciplinary team tested the hypothesis proposed by Jacobsen in his initial survey in 1933, with contributions from geomorphologists and other technical specialists. In the Diyala Project, for the first time, Adams had access to aerial photography, in the form of mosaics. Adams later carried out the Uruk Survey in the 1960s (Adams and Nissen 1972) and the Nippur Survey in the 1970s (Adams 1981). For these last two surveys, he had the use of air photographs, done on contract for the Iraqi government by KLM in 1957, in addition to maps. In 1966, when I was carrying out the Kish Area Survey (Gibson 1972), I was allowed to buy maps and air photos of the entire area from Baghdad to Nippur. Adams, at the same time, bought the same kind of coverage for the area from Nippur to Basra. I am not certain if Henry Wright, who was doing his Eridu Survey in the same year (Wright 1959; 1981), had access to air photographs. We were able to buy the maps and photos on the condition that we left the maps and photos in the offices of the Directorate General of Antiquities. In subsequent years, due to a shift in government and heightened security, it proved to be difficult to gain access to these materials, although not impossible. When the Iran-Iraq war began in 1980, security police removed them from the Antiquities office and we never recovered them.

The salvage operations in connection with the Tabqa Dam in Syria in the late 1960s forced scholars to take an interest in the assessment of major areas and not just sites. The dozens of excavations were important, especially the eye-opening Uruk settlements, but putting all sites in context was equally important, beginning with the surveys that were carried out as a preliminary step. The later salvage projects in the Khabur and the Tishrin areas of Syria in the 1980s added to the stress on entire areas. But most often, surveys up to that time were done from automobiles, stopping

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[2] Later, Arabic versions were made of the maps, and in the 1930s, Germans created a set. Map collections in libraries around the world often cover Iraq with bits and pieces from all three sets. In the 1970s, a Polish team had a contract to re-survey the country and they set up new benchmarks in many places, but I have never seen any output from that project.

[3] Adams' work in Iran was followed up by his students, Frank Hole, Kent Flannery, Henry Wright and Gregory Johnson, and later by their students, but there were other researchers doing survey in that country, especially those connected to Robert Dyson of the University of Pennsylvania and the French team centred on Susa.

where a site was obvious or marked on a map, or visible on an air photograph,

It was in this atmosphere, in which the Syrian Antiquities service encouraged survey, that Tony Wilkinson entered the picture and altered survey in a major way. He had already worked out his method, nicely illustrated for me in the1980s in the North Jazira Project associated with the Tell al-Hawa excavations in the Eski Mosul Dam Salvage area. He also carried out survey around Abu Salabikh in the south. At that time he was the Assistant Director of the British School of Archaeology in Baghdad.

In the 1990s, when the Sanctions on Iraq made it impossible for the British School to continue functioning in Iraq, he took a research position at the Oriental Institute of the University of Chicago. In that position, he initiated, or participated in, numerous projects in Turkey, Syria, Yemen, and elsewhere. Sometimes as a side project of an excavation, Tony would enter an area and usually with a student or two, he would do a survey that did not just find sites, but laid out the ecological history of the area. His work in the Balikh Valley, around Tell Beydar, and Hamoukar has allowed the reconstruction not only of the settlement history, but also the communication routes over a vast area from the bend of the Euphrates to the vicinity of Mosul (see Ur 2010 for summary of results and bibliography).

Essential to all current landscape work by hundreds of archaeologists around the world is the availability of satellite imagery and GIS.[4] By the early 1980s, large-scale images were available for broad-scale issues, for instance Adams' use of a Landsat image to derive a plan of ancient levees in southern Iraq (Adams 1981: fig. 6), and, in time, more detailed, multi-spectral images for smaller areas became available, but usually at some cost. A real breakthrough came with the release in the early 1990s of the CORONA images. These were cheap, easily bought, and would allow a comparison of landscapes as they were in the 1960s and 70s with the landscape visible in current images. For much of the Near East, these early images have proved invaluable because many of the areas have undergone massive change through agricultural, industrial, and urban development.[5]

Under Wilkinson at Chicago, dozens of students were introduced to landscape analysis, and many have made major contributions to the field, including the use of images to locate ancient routes and water control devices in Assyria (Altaweel 2003; Ur 2005), and to map potential sites in areas where ground-truthing is not yet possible (Altaweel 2006; 2007; Hritz 2006). With satellite images, they were able to verify or correct the positions of sites located by triangulation in earlier surveys by Adams, Wright, and me in the south and by Iraqi archaeologists in the north. The addition of several thousand other probable sites, by Altaweel in the north and Hritz in the south, enabled us to create a database that was put on a 'no-strike' list during the war of 2003. This database continues to be monitored for signs of destruction from looting, military action, and industrial or agricultural incursion. Carrie Hritz and Katharyn Hanson, along with Emma Cunliffe and Michelle de Gruchy at Durham, are continuing to monitor Iraq while expanding the analysis to Syria.

Wilkinson's generosity to students has resulted in numerous dissertations at Chicago, Edinburgh, and Durham. But his influence is much more widely spread through his articles and his book on archaeological landscapes in the Near East (2003), and through CAMEL, the remote sensing lab he established at the Oriental Institute. Under the directorship of Scott Branting and Emily Hammer, CAMEL has expanded its holdings and has become an international resource as well as a training facility. Scholars who have not studied under Wilkinson have still been influenced by him, and have made major contributions by following his lead, e.g. Simone Mühl's dissertation/book (2013) on a huge survey in the Kurdish area of Iraq. But his influence continues to grow through his former students at Chicago and Edinburgh who are now teaching and graduating other landscape specialists, making landscape study one of the most productive sub-areas of archaeology. In addition, his students and former students from Durham have been activated to carry out a variety of projects, many springing from Wilkinson's Fragile Crescent Project.

Although the regions open to any kind of research have shrunk drastically in the past three years, analysis of images can still proceed. The current burst of archaeological activity in the Kurdish region of Iraq includes major surveys by Altaweel and Mühl near Sulaymaniya, by Ur around Erbil, by Şerifoğlu and Casana in the upper Diyala, and by other teams in other areas, all of which are just beginning to be reported in print.

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[4] See Hritz 2014 for an authoritative, detailed account of the evolution of landscape studies and the role of aerial photography, cartography, and GIS/satellite imagery.

[5] It is not generally known, but Bob Adams had a key role in having the CORONA images declassified. While he was Secretary of the Smithsonian Institution, he was seated at a dinner next to James Woolsey, then head of the CIA. When asked about his research, Adams told Woolsey about his surveys, and said that he had come to a halt in interpreting ancient settlement patterns because he no longer had access to air photographs. Woolsey then told him about the CORONA images, which were so obsolete that they were useless to the military or intelligence agencies. He said he would see what he could do. Adams told me about this at the time, and when the CORONAs were made available, I phoned him to thank him. He was not aware that they had been declassified, but immediately began to put in orders.

Wilkinson's method has always centred on intensive, walking survey, examining sites in relation to the geology and geomorphology and to living and dead streams, and the collection of sherds not just on sites, but in the areas around them, to give an approximation of the agricultural sustaining area. His work on hollow ways is important. He brought a heightened level of observation, data collection, and new questions to ask of the material. His conclusions were so convincing that you wondered why we hadn't all seen them before. He never stood still, but instead went on to new questions and new methods, seeking answers to ancient demographic trends, local and interregional trade, development of complex societies, etc. It was his vision that saw the potential in creating an agent-based model for ancient Mesopotamia, and a great start was made toward that goal, as is reflected in the book that resulted (Wilkinson *et al.* 2013). His more recent research on the northeastern frontier of Iran and his involvement in documenting damage to archaeological sites in Syria reflect his commitment to intriguing and/or critical issues.

To walk or even drive through a landscape with Tony was a great experience, and I have done this in Iraq, Yemen, and Syria. We may think that we know a lot about an area, but Tony's training in the earth sciences gave him an ability to read a landscape the way most archeologists do not, seeing a Pleistocene terrace when we see only a rise or a ridge.

In Yemen, the intricate pattern of mountains and terraced slopes required different approaches to those used in Iraq or Syria. Even with very good quality air photographs and maps, it was not easy to see sites. After talking to local people and clambering up to the top of several mountains, he began to correlate what he saw with what was visible on the photos, and was able to recognise which would reward the climb and which would not. That particular field experience was punctuated by political events, and our initial survey season included one night in which, after we had gone to bed in the Potato Project in Dhamar, we were awakened by artillery shells passing over us in both directions. Initially, we thought it was just another wedding, but it became clear that the camp of northern soldiers to the north of the town and the camp of southern soldiers to the south were discussing the benefits of the unification of the country that had taken place a year or so before. The next morning, we prepared to leave for Sana'a, but our Yemeni co-director came in and said everything was fine, so we went out for the day's survey, passing the southern camp, where soldiers were coming out to buy bread from shops across the street. That night, we heard more gunfire, and thought the fighting had started up again, but that did turn out to be a wedding. A few days later, when we ended our season, we arrived in Sana'a to find out that the civil war had broken out that morning, and that the first action had been in Dhamar, with the southern troops leaving their camp and moving around the town, blowing up the local power substation, and then heading east and south toward Aden. We returned a year later to continue the work.

In all the areas I have worked with Tony, I was struck by his quickness to discover the best place to look for a specific answer. I was confident, as a dig director who had to pay the bill for a backhoe, that the cuts we made would produce results because Tony had decided where to locate them. Tony was quick to seize any opportunity to examine dirt. In the 1980s, while at Nippur, I decided to take the crew to visit Umm al-Hafriyat, a site I had dug in 1977 out in the desert to the east. We found the desert much changed, with a huge berm around a newly revived Delmaj marsh, and a tremendous ditch, 7 metres deep and about 20 metres wide, running northwest to southeast for many kilometres. We also ran into an Antiquities team carrying out a salvage operation on a small site in the projected path of the ditch. No one had told us that any of this was happening. But it was obviously the realisation of a project to desalinate the alluvium, first proposed under the Ottomans by Willcocks (1917), and planned in detail by an American engineering firm in the 1950s. Only the northern part of the programme, the Mussayib Project, was finished by Dutch engineers before the Revolution of 1958, and through the next three decades nothing more was done; the Mussayib portion was being used only as an irrigated area, and was progressively salting up. In the 1970s, a Greek company began to cut the subsidiary drains that were meant to bring the salty water from the fields to the main drain, which was scheduled to be done but was not completed at that time.[6] Having seen the cut for the main drain, I quickly went to Baghdad to see Tony and say that we had a fantastic opportunity to examine the alluvium in a way that had never previously been possible. He returned with me and for one day we drove north up the cut, stopping to observe the profiles, recording one site four metres down that yielded a C^{14} date and a couple of sherds that indicated a small Ubaid village, completely buried. Unlike Ras al-Amiya, which was discovered by the cutting of a drain in the Mussayib Project (Stronach 1961), this site had left no sign on the surface. We also ran over an ancient, sand filled river course that was located in the bottom metre of the trench, coming from one side of the cut to the other, and then back again. This did not appear to be as big a course as the one passing through Umm al-Hafriyat and Adab, as mapped from air photographs by Adams during his Nippur Survey (Adams 1981: fig. 21), but it must be related. When we were digging Umm al-

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[6] The Iran-Iraq War came, and the Third River was not cut until the 1990s, and even then most of the drains were not linked.

Hafriyat in 1977, we could easily see, north of the site, the meanders that Adams had mapped. They were easily visible, not as differences of soil on the surface, but as an extensive, meandering grove of tamarisk bushes that were sending down deep roots into the old riverbed. Stephen Lintner, a geomorphologist who worked with us, sank a pit in the middle of the tamarisks, but at six metres he had not hit the streambed and was forced to quit because it was becoming dangerous.

Everyone who has ever had the privilege of working with Tony has similar stories to tell. He made us think in ways we would not necessarily have done. Every project he cooperated on was improved, and his own projects were truly innovative. We have all appreciated his intelligence, his decisiveness, his calm assessment of a situation and his ability to cope with adversity. Administrators valued his grant-writing abilities, and his financial scrupulousness. We all enjoyed his good humour, and even his love of the Blues. Not many archaeologists can say that they have played harmonica with Buddy Guy.

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The Search for Hidden Landscapes in the Shahrizor: Holocene Land Use and Climate in Northeastern Iraqi Kurdistan

Anke Marsh and Mark Altaweel

Introduction

The Shahrizor basin is an inter-montane plain, which forms part of the Zagros fold-thrust belt. It is located between Slemani (or Suleimaniya) and Halabja, in Suleimaniya province (Figure 2.1). Although there has been much research on the structural geology of the region, there has been no palaeoenvironmental research undertaken until 2011 (Altaweel *et al.* 2012; Marsh 2015).

To redress this, in 2011, and in conjunction with other project members conducting archaeological survey and excavations in the region, we started palaeoenvironmental fieldwork in the Shahrizor plain to better understand local change throughout the Holocene, using sedimentary, microfossil (phytoliths, diatoms, and ostracods) and speleothem analyses. The main aims of the project are 1) to reconstruct the evolution of the plain during the Holocene, 2) to better understand the human-nature relationship and human modification of the environment, 3) to collect robust climate data for the Holocene, and 4) to better understand past alluvial processes and how these might impact site visibility (via erosion and burial).

An overriding theme of this project is the importance of collecting local proxy data in order to reconstruct and understand local environmental and cultural change. Although there have been some good palaeoenvironmental and palaeoclimatic studies carried out elsewhere in the Near East, far too many palaeoclimate reconstructions have been attempted for Mesopotamia without using good proxies or depending on very distant proxies such as sea cores or Soreq cave in the Southern Levant, reaching potentially erroneous reconstructions. The case study presented here demonstrates why it is so important to understand local environmental conditions rather than assuming more distant proxies represent what happened in the region during much of the Holocene. The Shahrizor is a case where general Near East palaeoenvironmental trends seem to be followed at times, while on the other hand more regional and local variations appear to show important contrasts. Differences in the environmental record, particularly in comparison to today's setting, should be reflected in the different economic and settlement strategies adopted by past inhabitants of the Shahrizor, including adopting different cultural trajectories and shaping the region's geopolitical position.

In order to accomplish these goals, we are using a multi-disciplinary approach that includes geoarchaeological and phytolith analyses, combined with data from speleothems, other microfossils, archaeological survey and excavations, and total station readings of topography.

The geoarchaeological analysis comprised mainly of the identification and characterisation of alluvial sedimentary layers, which can inform on changing hydrologies and the evolution of the alluvial plain throughout the Holocene. Phytoliths ('plant rocks') are cells and other plant parts, which have been infilled by silica and other minerals and which are then preserved in sediments and soils after the plant decays (see Piperno 2006 for further discussion; Figure 2.9). In this study, phytoliths were analysed to complement the sedimentary data, determine vegetation change, to see if land use patterns and agricultural strategies could also be detected in the offsite and onsite samples, and to understand resource and crop use onsite. Samples were also taken for ostracod analysis. Ostracods can indicate past lacustrine environments as well as provide possible palaeoclimate indicators (Horne *et al.* 2012).

Speleothems were also collected and analysed. Among the strongest terrestrial climate proxies available are those derived from speleothems (McDermott 2004), which are stalagmites formed in limestone caves. These records provide stable isotopes, particularly $\delta^{18}O$ and $\delta^{13}C$, used to reconstruct past temperatures and precipitation. Speleothems are generally dated using Uranium series (U-series) methods, with Uranium-Thorium being among the most common. The advantage of speleothems is that they provide highly dateable proxies, often with precision within less than a decade during the Holocene, and are independent of sea and ice core data, which are better for more general global circulation or climatic patterns (Broecker 1998).

To begin the study, we will present background information on current conditions, which demonstrates one endpoint of our study. We then present our data on past land use and climatic conditions in the region

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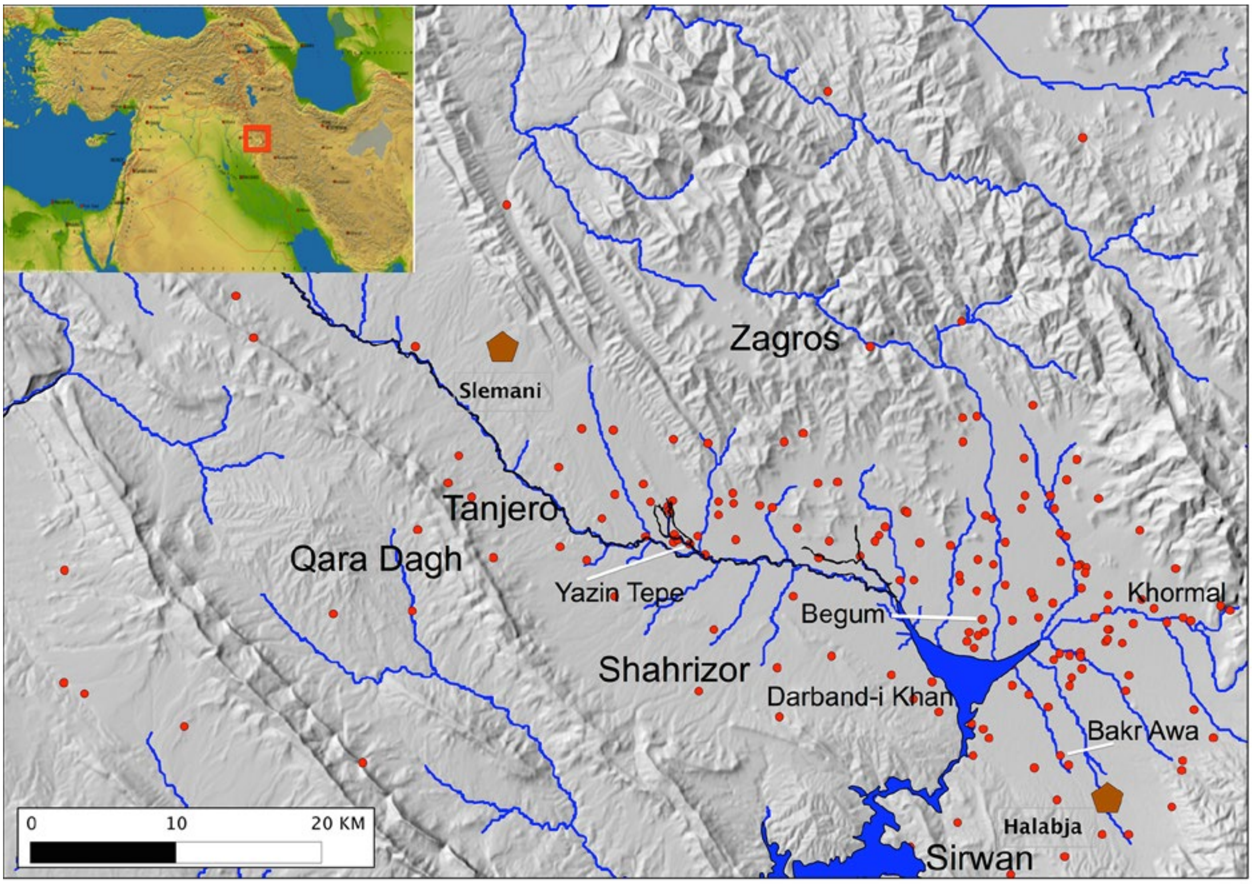

Figure 2.1. Map of the Shahrizor showing archaeological sites (circles), key modern cities (pentagon shapes), and geographic features. The insert shows the location of the study area in the Near East.

using geoarchaeological, phytolith, other microfossil, and speleothem data. These data cover different parts of the Holocene, likely spanning from the early Holocene until relatively recent. Finally, we discuss why these results are critical to understanding local palaeoenvironmental conditions and their implications for understanding past cultures in the region.

General background

The Shahrizor is a relatively large intermontane plain and forms part of the Shahrizor-Piramagroon basin (Ali 2007). Highland regions, primarily the Binzird, Baranan and Qara Dagh to the west, and the Zagros mountains to the east, bound the valley (Figure 2.1). The Tanjero is the major river that runs through the plain from the northwest to the southeast and drains into the Darband-i Khan Lake, which is a modern dam lake. There are many seasonal streams and wadis, with a few perennial streams fed by springs (e.g., in the Khormal region and around Yazin Tepe). The plain contains Pleistocene terraces, hills, and fan deposits at the base of the slopes of the surrounding mountains (Altaweel *et al.* 2012).

Modern climate

The climate is characterised as continental Mediterranean. Mean temperature varies from 5°C in January to over 30–40°C during the summer months (Ali 2007). Precipitation generally ranges between 600–1000 mm a year, depending on the location in the basin. At the Slemani climate station, rainfall averaged 678 mm/year between 1936 to 2006 (Ali 2007; NOAA 2014).

Modern landscape and land use

Despite relatively high rainfall, only about 30% of the land was used for grain agriculture in the last half century, with about 50% of the land being used for grazing (Davies 1957; Mühl 2012; Sehgal 1976). Cultivated plants in the past included tobacco, rice (possibly Qush Qaya), fruits, and berries. While wheat and barley are typically grown now, vegetable plots and fruit orchards can be found in arable fields as well as on the terraced hillsides. There are also small areas of riparian woodlands, mostly along the Tanjero and other perennial streams. In higher elevations, there are wild flowers, oak, pine, and Prunus trees with some

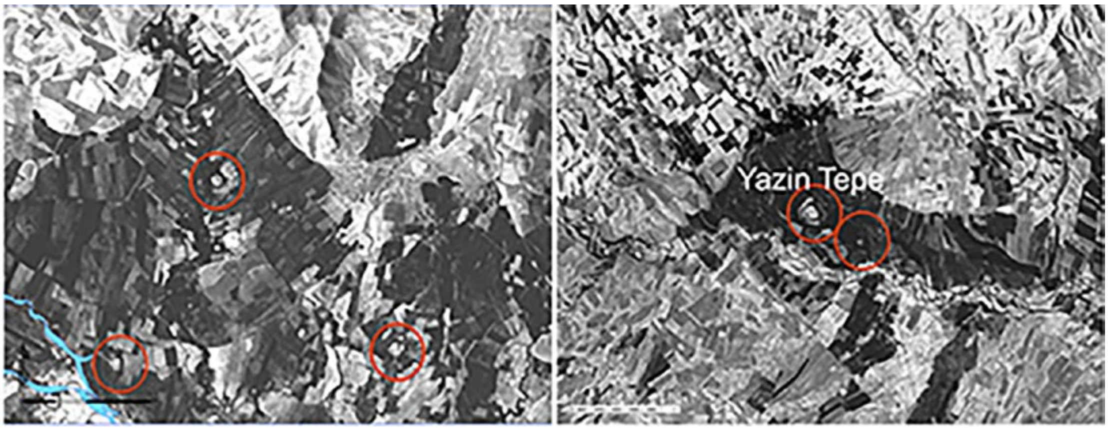

Figure 2.2. CORONA images showing archaeological tells (red circles) and active valley alluviation indicated by areas near the darker colours. Such alluviation in the past has contributed to diminishing visibility of archeological sites in the Shahrizor, as sites become buried over long periods.

naturally occurring open woodland, shrubs, and wild fruit found (e.g., wild grape observed by Dorian Fuller in 2014 (pers. comm.)). The hill-slopes are also in the process of being reforested, mainly to combat the problem of erosion.

Geomorphological observations

While the hills and mountains, created through tectonic processes, are the most prominent features surrounding the valley, geomorphological processes have also shaped the valley over the millennia. These include erosion and deposition by rivers, mass wasting and slumping along the steep slopes. The foothills and mountains are highly incised, indicating past and present stream flow.

Fluvial processes are not only active in the hills and mountains, but also in the plain itself (Figure 2.2). Deposition of sediments certainly affect the visibility of archaeological remains, which are also impacted by modern anthropogenic processes. Many of the Pleistocene terraces appear as low hills and are made up of mostly gravels that are now commonly excavated for building materials. These Pleistocene terrace hills represent those areas not as impacted by fluvial erosion: much of the Pleistocene terraces have been incised by Holocene-period channel cutting and buried with alluvium in some areas. Archaeological sites are often found on these terraces (e.g., see Altaweel *et al.* 2012), as they offered likely protection from flooding, stream flow, or even conflict. The Holocene terraces are more difficult to detect, other than by coring or excavated sections, because many of the earlier terraces are eroded and covered by later sedimentation.

Holocene sedimentation is heavy in the region partly because of the increased erosion due to denuding of the hill and mountainsides, but also because of stream channel activity, as will be discussed. In some areas of the region, cores and the trenches reached 6–8 metres before encountering Pleistocene gravels; similar observations were noticed in our earlier fieldwork (Altaweel *et al.* 2012). There may indeed be areas where the Holocene sediments are closer to 9 metres or more. Given these depths of sedimentation, many archaeological sites are likely to have been buried. This is also suggested by the cultural materials (especially brick and pottery) that have been found in section profiles many metres below the surface.

The alluvial plain soils are described as fertile, reddish-brown in colour, and having a high $CaCO_3$ content. The soils are classified as Calcisols (Ali 2007) or Calcixerolls (Sehgal 1976), with the reddish colour indicative of the high iron content. These soils are also known as terra rossa, a soil that is common in the Near East and across the Mediterranean and composes much of the soils found in the lower alluvial plains (Altay 1997; Bronger and Bruhn-Lobin 1997). Rendoll and Xerorthent soils are found on the mountain slopes (Ali 2007; Sehgal 1976). The uplands generally have thinly or poorly developed soils. The soils are fairly deep in the basin; we have documented soil profiles greater than a metre (Altaweel *et al.* 2012). The soils generally consist of silts (50–65%), clays (30–45%), and sands (5–10%) (Ali 2007), and are generally homogenous. The soils are alkaline (7.5–8.2 pH), with our own geochemical analysis indicating consistently more than 8.0 pH for areas sampled throughout the valley.

Methods

Geoarchaeological survey

Sections from wadi and well cuts were recorded (drawn and photographed) across the plain. In addition, three areas (Bakr Awa, Begum and Yasin Tepe) were

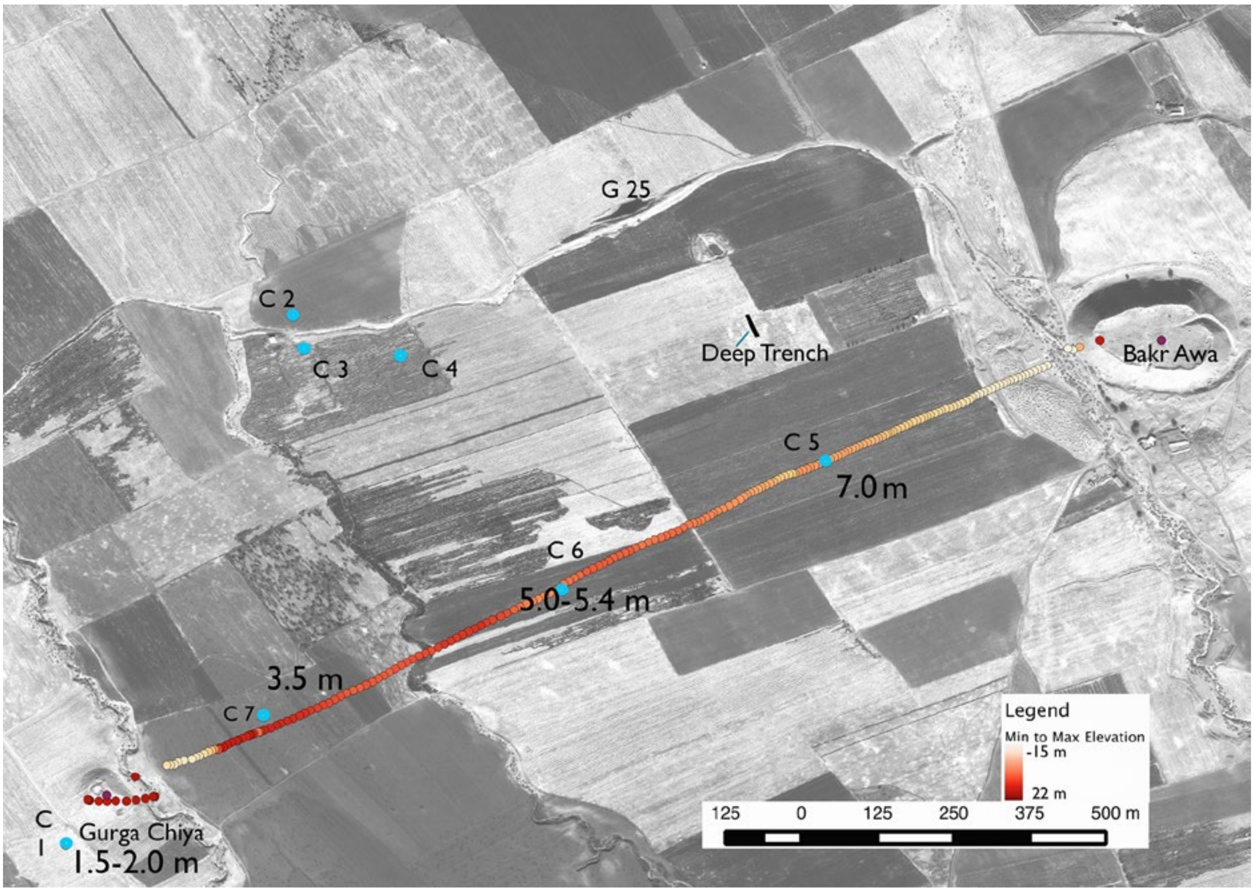

Figure 2.3. QuickBird November 17, 2010 image showing the Bakr Awa area investigated from 2011–2012. Points labeled as "C" are cores. Depth of sediments (in metres) before reaching Pleistocene gravels are indicated on the image.

selected for more detailed geoarchaeological survey. Trenches were excavated, recorded, and sampled. The sections were drawn and described (colour, grain size, inclusions, and other features), on forms specifically designed for this project. Bulk sediment samples were described, using parameters such as colour, grain size, plasticity, and consistence. Cores were also taken from these areas.

Phytoliths and other microfossils

The processing protocol is after Rosen (2005). Each initial sample (800 mg to 5 g depending on context) was sieved to remove sands. Carbonates were then removed using a 10% HCL solution. Clays were removed using the settling method (based on Stokes' Law), followed by firing in a furnace at 500°C to burn off any organic material. The phytoliths were then separated from the remaining sediment using sodium polytungstate (SPT). The phytoliths were weighed and mounted on slides with Merck New Entellen.

The slides were examined under a transmitted light Alphashot microscope at 400x magnification. Phytoliths were identified and counted for a total of 400 for single celled examples, 100 for multi cells, if possible, as some slides had few phytoliths, then tabulated on specially designed count sheets. The total number of phytoliths per gram was calculated (i.e., using number per slide/mg mounted*total phytolith weight*total sediment weight*1000) and these figures then analysed statistically.

Speleothem analysis

In Iraqi Kurdistan, there are a number of limestone caves (Stevanović *et al.* 2009), many of which contain speleothems. Two caves, Kuna Ba and Gejkar, are being monitored (to properly reconstruct palaeoclimate, monitoring of water and air circulation within caves is critical: Mattey *et al.* 2008), and speleothems have also been collected, which are currently being analysed.

Results from the 2011–14 seasons

Results from the first three years of research are presented here, including the geoarchaeological survey from Bakr Awa, Begum, and Yasin Tepe areas, phytolith analysis results from offsite contexts at Bakr Awa and Yasin Tepe, and onsite data from the multi-period site

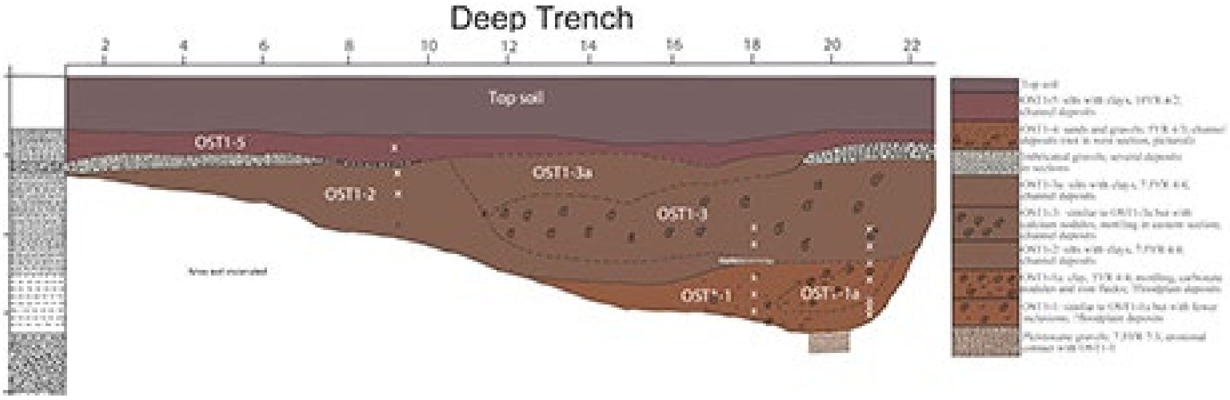

Figure 2.4. Reconstructed sediment profile showing the depositional sequence in the deep trench and lithology log. Measurements are in metres (Marsh 2015).

of Bakr Awa. Preliminary results from a speleothem collected from Kuna Ba cave are also presented.

Geoarchaeological results

Three main regions near Bakr Awa, Begum, and Yazin Tepe (Figure 2.1) were studied in detail using trenches and cores. Cuts from wadi channels and wells in other parts of the plain were recorded. The following summarises the results.

Bakr Awa Region

A large trench was excavated between the sites of Bakr Awa and Gurga Chiya (Figures 2.3 and 2.4). At about 6 m down, a gravel layer was reached. Although gravel layers were encountered throughout the section, these differed to the base layer gravels. Firstly, the colour of the base layer gravel differed, as it was pinkish rather than the blue of the gravels above, suggesting a different Cretaceous limestone source material. Secondly, there was an abrupt, erosional boundary between the base layer gravel and the clayey layer above. It is likely that this boundary marks the beginning of the Holocene sequence. A sherd of pottery was found at about 5 m down, also indicating that these deposits are Holocene in age. A diagnostic sherd (Achaemenid /Hellenistic; Altaweel *et al.* 2012) was found above the top wadi cut in the western side of the deep sounding, about 1.8–1.95 m below the surface (Figure 2.4: Layer OST1-5). Thus the sediments between circa 2 m to 6+ m represent Holocene sedimentation from circa 12,000–2300 BP.

A reddish brown clayey layer is found above the Pleistocene gravels. This layer contained iron flecks, which are flat and flexible, and a few calcium nodules (or concretions). Within this layer is a lens (Figure 2.4: OST1-1a), with an indistinct boundary, which was mottled and contained a higher number of calcium nodules. Above OST1-1 and 1a are two further layers, OST1-2 and 3. There is a more distinct boundary and colour change from OST1-1 to OST1-2; the boundary between OST1-1/1a and OST1-3 is less distinct, but there is still a change in colour to brown (7.5TR 4/4). OST1-3 cuts through OST1-2: there is a small gravel lens visible under OST1-3 in the western side of the trench (Figure 2.4); however, the gravel layer is much more evident on the eastern side of the trench (not pictured), so it seems the west side catches the edge of the channel. The gravels on both sides of the trench are imbricated and indicate that flow was northerly, going towards the confluence of the Diyala and Tanjero (where the dam lake is now located). OST1-3 is differentiated from OST1-2 and 3a by the presence of the calcium nodules. Boundaries between these layers are indistinct.

In the western section (Figure 2.4), layers OST1-2, 3, and 3a are overlain by gravel deposits. This is mirrored on the eastern side, except that OST1-3a is not present and OST1-3 shows some mottling. Again there seems to be a streambed here, and the imbrication of the gravels indicates that flow is also moving towards the old confluence.

The gravels are overlain, with a sharp boundary, by OST1-4 on the eastern side, a reddish brown (10YR 4/3) deposit consisting of mainly sands with some gravels. This is not reflected in the western section. OST1-5 (dark reddish brown: 10YR 4/2) overlies OST1-4 in the eastern section and directly on top of the gravels in the western section. This in turn is overlain by a fairly well developed soil horizon. The soil further indicates a change in hydrology, with decreasing sedimentation and increasing plain stability, allowing for the development of soil horizons. This shift occurred in the last 2300 years.

Some of the layers were very difficult to differentiate (especially OST1-2 and 3). There were also several gravel deposits, indicating a regime of channel switching and hydrological changes, which would have eroded parts of the underlying layers and deposited new sediments over time. Although slightly different colours could be discerned (reddish to brownish), with lenses of mottling and increased calcium or iron nodule content present in some areas, the boundaries between these layers were very indistinct. These are not graded boundaries as there is no change in grain size. The boundaries seem to have been blurred, perhaps by post depositional changes. In addition, there is no trace of internal structures, (i.e., lamination).

The bulk samples taken from layers are generally crumbly in texture but also contained considerable amounts of clay. It is likely that this sediment is reworked terra rossa soil from the limestone uplands. As noted, some of the layers were mottled. This could be the result of fluctuating wet/dry periods (i.e., where the land surface was at times exposed and other times waterlogged).

The gravel cuts suggest an active floodplain where channel switching was recurrent throughout the Holocene. In some of the layers (e.g., OST1-1a and 3), there are carbonate nodules evident in varying concentrations. This could indicate warm humid conditions (Rosen 1997), where there are high temperatures combined with high rainfall and water table. These nodules are associated with the mottling discussed above, and waterlogging may have been also caused by a higher water table and rainfall.

Several cores (Figure 2.3) were taken in 2012 between Bakr Awa and Gurga Chiya. Observations indicate that sedimentation is similar across this area, with interspersed wadi gravels and channels and silty-clay deposits; however, the main difference is the depth of sedimentation. Sedimentation appears to be deepest near Bakr Awa, while deposits are shallower near Gurga Chiya (Figure 2.3). One core (C1) was taken on the Pleistocene terrace on which Gurga Chiya is located. Sedimentation is relatively shallow (1.5–2.0 m) on the terrace as expected, and the sediments are a mix of colluvium and alluvial deposits. Another core, C3, contains a possible fining up sequence, starting with pebbles at about 3 m below the surface, shifting into silts and then silty-clay before soil formation at 1.5 m down. This is typical for river sequences and thus has been interpreted as channel deposits. C5 is closest to the deep trench and its stratigraphy resembles the deep trench: the deep trench and core seem to be reflecting one or more of the same channels, although the original channel is somewhat deeper in the core (the base layer gravels are at 7 m depth). Cores C6 and C7 are progressively closer to Gurga Chiya and are at slightly more elevated positions. Core C6 has Pleistocene gravels starting at about 5.0–5.4 m down, with a pinkish matrix similar to what was found in the deep trench; this is overlain by clays. A channel cut evident at about 4 m down. While it is possible that this gravel layer is the same channel as detected in C5 and the deep trench, it is also possible that it is another branch of the stream system that flows into the confluence area. C7's Pleistocene base starts at about 3.5 m down, showing its position further up the original terrace. This is overlain by sandy clays and clays. This deposition would have occurred much later in the Holocene and could reflect channel movement. Before this deposition, this part of the Pleistocene terrace would have been exposed.

Begum Region

In the region of Begum (Figures 2.1 and 2.5), three trenches were recorded. The main issue with this area is the close proximity to the Darband-i Khan dam lake, which was created in the 1960s after the completion of the dam with the same name. Not only did this lake have a devastating effect on the archaeology now submerged, and the ecology of the river system where the Tanjero and perennial springs from the Khormal region meet, the sedimentation and buried sediments were also adversely affected. The sediments here were similar in consistency to those near Bakr Awa, in that they were mainly silts and clays, but they were mostly grey (10YR 7/2, light grey) or yellowish-brown (10YR 5/2) in colour. The difference in colour could of course be caused by the parent material being different; however, this seems unlikely given that there rest of the plain, as far as investigated, seems to be made up of very similar clayey-silt reddish sediments with intercalations of sands and gravels. A more likely possibility is that these sediments were originally reddish sediments derived from the terra rossa, but the dramatic rise in the water table changed the sediments' colour to a greyish hue due to reducing conditions (Wildman *et al.* 2010). This area under water fluctuates from season to season, with some sites becoming visible in the summer months; this seasonal fluctuation also impacts the geochemistry and stratigraphy of the sedimentary record.

As with Bakr Awa, deep sedimentation and channel cutting the Pleistocene terraces is evident. Near the site of Begum, a Halaf and later period site (Hijara 1997), which appears to be on a Pleistocene terrace, trench G35 was excavated and had a depth of around 7 m or more, but the Pleistocene gravels were not reached. This area of sedimentation is deeper than that of the deep trench excavated near Bakr Awa. The exact depth was not obtained due to the fact that the water table was high and water was rushing into the trench, making further excavation impossible. Nearer to Shamlu, where trench G31 was located, only about 3 m depth was excavated, with the Pleistocene gravels again not reached because of the rising water level. Only to the east of Begum, the depth of G34 (Figure 2.6) reached 3.5 m before the Pleistocene gravels were located.

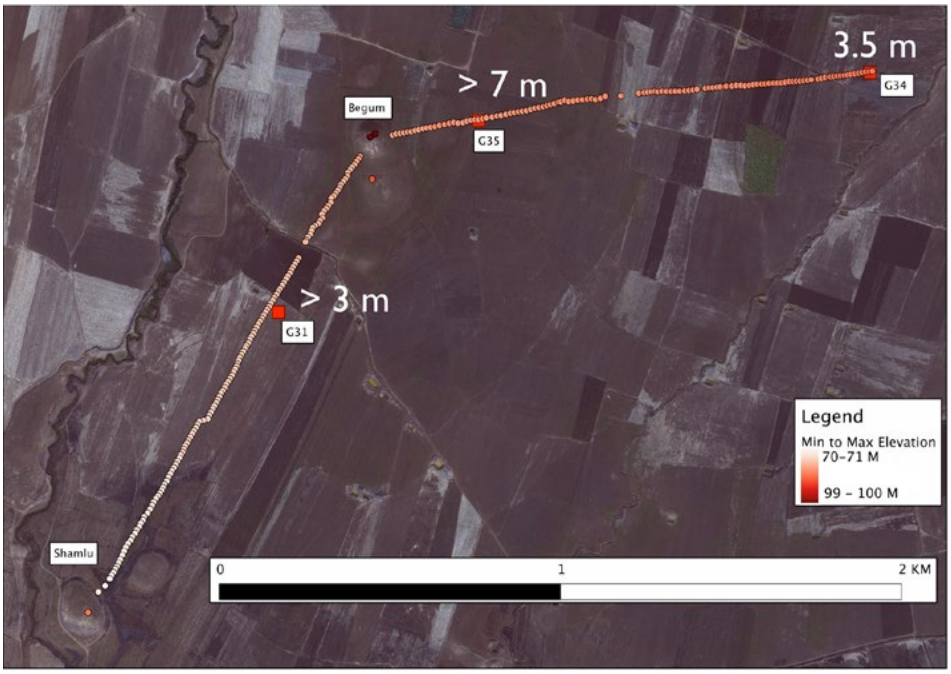

Figure 2.5. The region of Begum depicted in a November 17, 2010 QuickBird image with trenches excavated (G31, G34–35). The darker colours on the image reflect the high water table affecting soil colours on the image. The depths of Pleistocene gravels are indicated.

The total station results (Figure 2.5) show that the topography increases in elevation moving north and northeast of Begum towards G34. This all indicates that there is an underlying Pleistocene terrace, which was eroded by Holocene channel cutting and later covered by alluvium. The elevation dips down towards Shamlu, as it is going down towards the old confluence of the river systems. These initial channels cannot be dated, however, it is possible that they were created at around the same time as that of Bakr Awa, at the beginning of the Holocene.

Yasin Tepe Region

Yasin Tepe (Figure 2.1) is slightly different in that it sits on an outcrop rather than a Pleistocene terrace. The movement of the channels are also somewhat constrained by the underlying hard rock lithology. Unlike Bakr Awa, there are no channel cuts, instead there are more typical floodplain deposits, that change in grain size slightly, indicating channel migration across the plain. In 2011, a riverbed section near Yasin Tepe (Figure 2.7: G14) was photographed, drawn, and sampled for phytoliths. On top of Pleistocene (blue and pink layered) gravels were small layers of alternating silts and sands, with charcoal throughout. This is a Holocene-period terrace, but it has not been dated as of yet. This is an area that may have been farmed, with the relatively large charcoal deposits found indicating perhaps field burning. The layers alternate between clays/silts and fine-grained sands, but towards the top, there are minor layers of coarser sand, possibly indicating minor flash flooding episodes. The sediments are much greyer here, falling in the 10YR range, and are more typical alluvial sediments.

In 2013, we returned to the Yazin Tepe region and three trenches were excavated, drawn, and sampled (Figures 2.7 and 2.8), going along a transect from Yasin Tepe to the Tanjero. A total station was used in this transect to record the topography. Looking at the elevation results, a small increase in elevation near G32 is noticeable because a small archaeological site is located near G32 (Altaweel *et al.* 2012). The major dip in elevation is reflecting a stream channel, whose source is a spring located near the site. G32 (Figure 2.8) and G33 were excavated to about 4.5 m before hitting Pleistocene gravels, the depth of G30 only reached about 3 m as the excavator was not big enough to go further. No Pleistocene gravels were seen in this trench. The sedimentation is not as deep in this region as it is near Begum and Bakr Awa. The sediments in G32 are mainly yellowish brown (10YR 6/4) and different to those at Bakr Awa, with less evidence of terra rossa influence. The sequence coarsens upwards: The first layer above the Pleistocene gravels is composed of mainly massive clays, and the layer above is composed of massive silts. Above this layer is brown soil, with a depth of about one metre. In G32, there is a possible channel cut into the topsoil and going into the top sedimentary layer. Limestone rubble, bricks, and pottery sherds, with diagnostics dating to the Late Bronze Age, found in

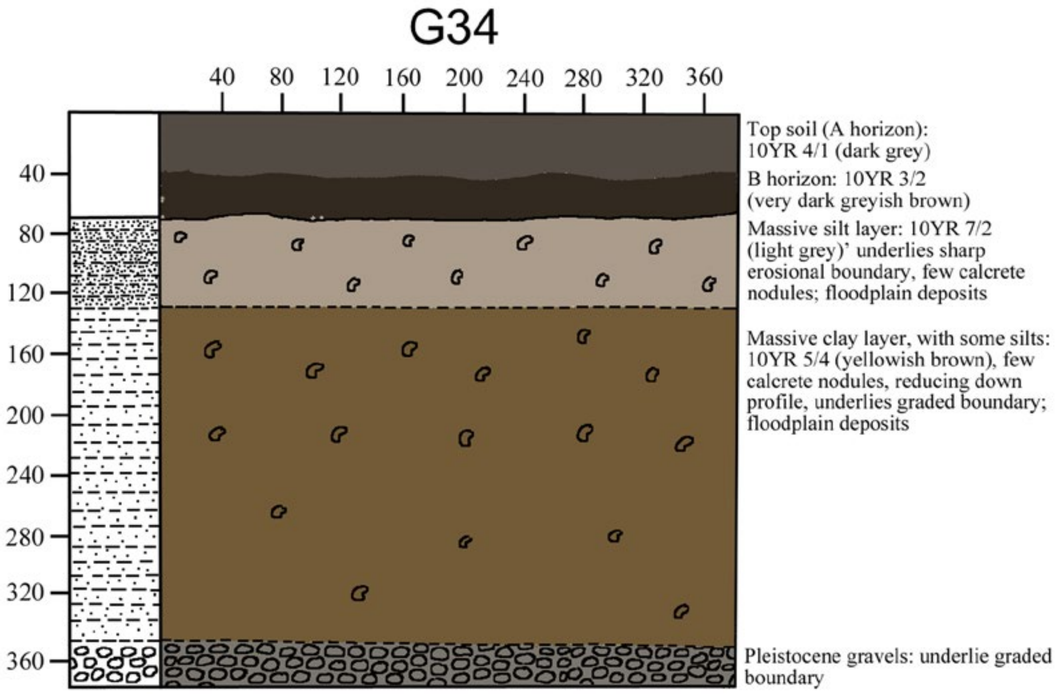

Figure 2.6. Sediment profile and lithology log of G34 in the Begum region (Marsh 2015).

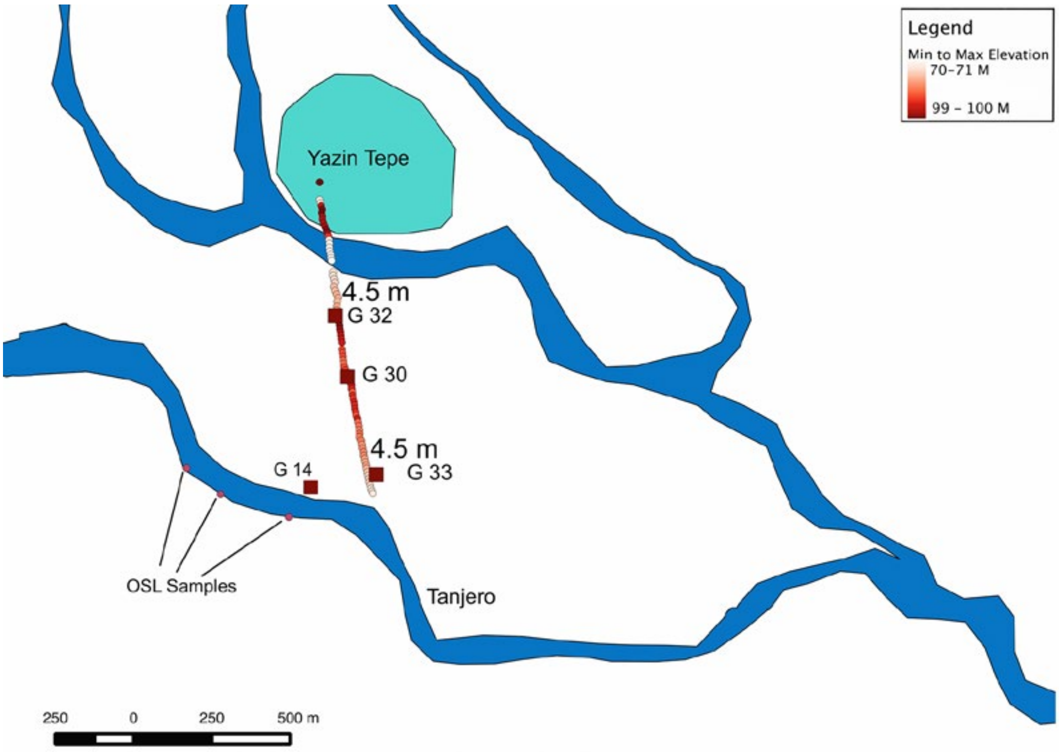

Figure 2.7. Trenches (G30, 32–33) and elevation transect in the region of Yazin Tepe with a sedimentary exposure (G14) investigated in 2011.

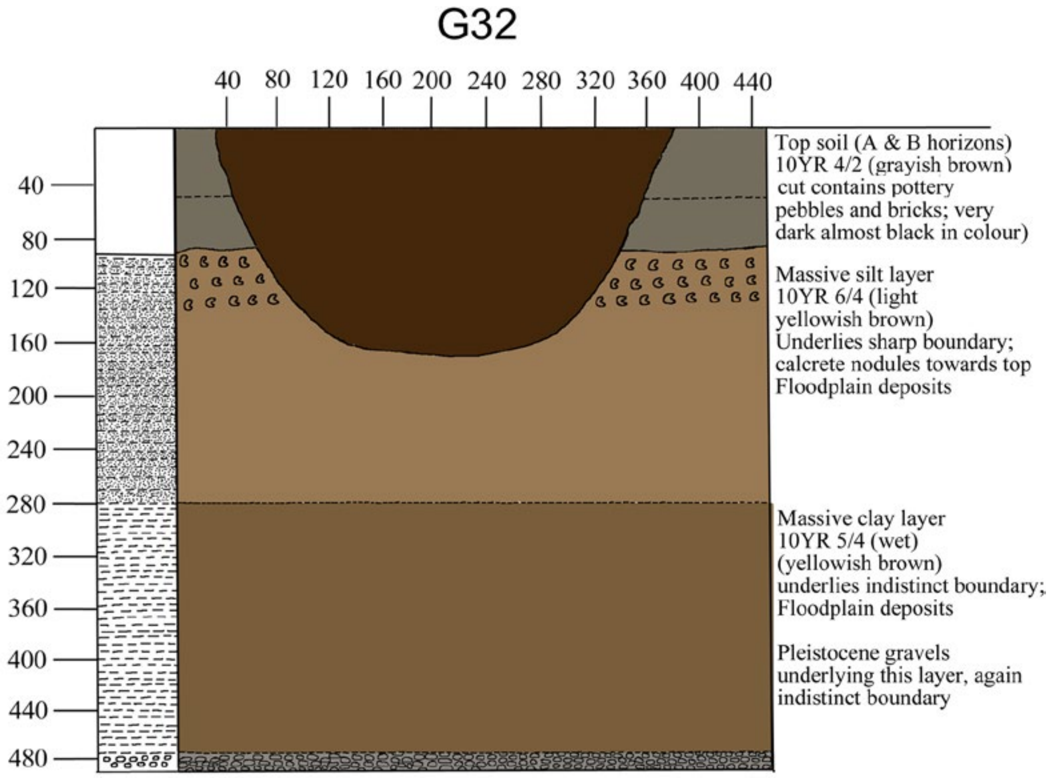

Figure 2.8. Sedimentary profile and lithology log of G32 from the Yazin Tepe area.

this cut, which may be associated with the nearby archaeological site. It is possibly a modern irrigation channel, but this has not been confirmed.

Trench G30 is very similar, although the full extent of the Holocene sedimentation could not be exposed. At the bottom of the trench, there is a clay layer, overlain by sands with some clays. Both have massive structures. The colours of the sediments do differ somewhat from G32, being more in the 7.5YR range (brownish) and thus more similar to those at Bakr Awa. The sedimentation may be a bit shallower in this trench than G32: gravels were seen at the bottom, which could have been the top of the Pleistocene layer. G33 again had similar sedimentation to the other two trenches, a massive clay bed overlying the Pleistocene gravels, and which in turn is overlain by a massive silt bed. The colours appear to be lighter here, and more yellowish (10YR 8/3: very pale brown and 10YR 5/4: yellowish brown). There is also an area in the second layer (the massive silt layer) and below the soil horizon, which is a lens of clayey silt and is a slightly different colour. The boundary was indistinct. This may have been a more waterlogged area in the floodplain.

The sediments in the three trenches likely represent floodplain deposits, the increasing grain size reflecting either a shift in stream power or location of the channel.

Phytolith results

Phytolith samples were taken from the multi-period site of Bakr Awa (Miglus *et al.* 2013) and from the deep trench near Bakr Awa and section G14 at Yazin Tepe (Table 2.1).

Offsite Samples

The samples (Table 2.1) taken from the deep trench are not dated, although all predate 2300 BP, as the samples came from near or below the Achaemenid/Hellenistic sherd found in the deep trench and above the Pleistocene–Holocene boundary. Attempts were made to date the sediments from the trench, but all AMS dates were found to be Pleistocene, indicating the sediments are reworked soil with older organic matter contained within. This also has implications for some, although not all, of the phytoliths that were found in the samples.

Total silica content of offsite samples is very low, all falling below 0.5%, which is expected as preservation is less in offsite contexts, mainly due to soil formation processes which can break down silica (Alexandre *et al.* 1997). Phytolith abundance was, thus, almost universally low. Counts (that is 400 for single cells and 100 for multi-cells, see above) were not reached for

Table 2.1. Offsite phytolith samples and their given depths and location.

Region	Sample	Number	Depth (metres)	Location	Relative date
Bakr Awa	P021	1	5.4	Deep trench	Early–Mid Holocene
Bakr Awa	P014	2	5.2	Deep trench	
Bakr Awa	P004	3	5.1	Deep trench	
Bakr Awa	P020	4	5	Deep trench	Pottery Neolithic or later
Bakr Awa	P013	5	4.9	Deep trench	
Bakr Awa	P003	6	4.9	Deep trench	
Bakr Awa	P012	7	4.6	Deep trench	
Bakr Awa	P019	8	4.5	Deep trench	
Bakr Awa	P002	9	4.5	Deep trench	
Bakr Awa	P011	10	4.3	Deep trench	
Bakr Awa	P018	11	4.2	Deep trench	
Bakr Awa	P026	12	3.8	Deep trench	
Bakr Awa	P001	13	3.4	Deep trench	
Bakr Awa	P025	14	3	Deep trench	
Bakr Awa	P010	15	2.7	Deep trench	
Bakr Awa	P024	16	2.5	Deep trench	
Bakr Awa	P009	17	2	Deep trench	
Bakr Awa	P023	18	1.8	Deep trench	Before or near Achaemenid/ Hellenistic Period (c. 2300 BP)
Yazin Tepe	P045	19	1.4	G14	
Yazin Tepe	P043	20	1.25	G14	
Yazin Tepe	P042	21	1.05	G14	

the majority of samples, with whole slides scanned; however, there was one exception, sample P023 (taken from OST1-5), which had a very high number of phytoliths, comparable to onsite samples from Bakr Awa. In many of the samples, there were fragmented and weathered phytoliths. The fragmenting could be related to transport, and weathering could be related to soil formation and other geochemical processes (see Marsh 2015 for a fuller discussion on taphonomy). Dissolution is also exacerbated by fragmentation. Figure 2.9 shows a summary of monocotyledon (grasses and sedges/reeds) versus dicotyledon (trees and shrubs) phytoliths. Figure 2.9 indicates that there are relatively high ratios of dicotyledon phytoliths in the samples. The values range between 20–75% in recovered phytoliths from samples. There do not seem to be any significant temporal trends, although towards the top of the deep trench section dicotyledons do decrease, at nearer to the time when the Achaemenid/Hellenistic sherd was deposited. This could indicate increasing deforestation around 2300 BP. There is also an apparent hydrological shift at this time (see above).

Sponge spicules and diatoms are present in most of the samples in small numbers, indicating the presence of water. The diatoms are mainly pennate, with some *Nitsczhia sp.*; two samples contain centric forms (P024 and P026). While centric diatoms tend to be more planktonic, thus indicators of deeper water, until further investigation, nothing very significant can be said of their presence. Sponge spicules were generally more abundant. In some samples (P014, P025), there are burnt phytoliths, and charcoal was present in most of the samples.

The comparative values of rondels, bilobes, and saddles (short cells from different monocotyledons with different climate/environmental requirements) show that, for the most part, rondels (from C_3 grasses, including cereals) dominate, indicating a temperate climatic regime for much of the Holocene sequence. There are some fluctuations in the numbers of bilobes (panicoids) and saddles (chloridoids), which may indicate variation in the climate.

Several indices, based on specific single cell morphotypes were also calculated and include: tree coverage (Alexandre and Meunier 1999; Alexandre *et al.* 1997; Bremond *et al.* 2005; Delhoun *et al.* 2003); Ic (climate) index (Barboni *et al.* 2007; Burrough *et al.* 2012; Twiss 1992) and the Fs (water stress) index (Barboni *et al.* 2007). Some caution with the results, though, should

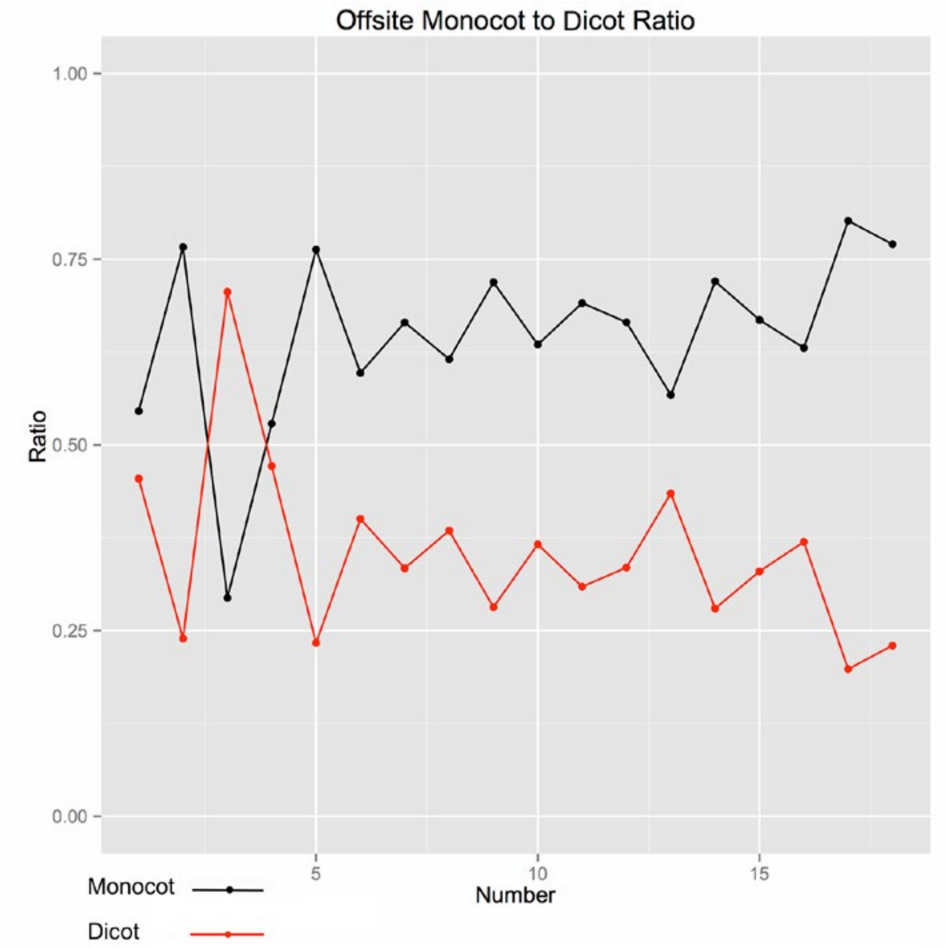

Figure 2.9. Ratio of monocotyledons (grasses and sedges/reeds) to dicotyledons (trees and shrubs) from offsite samples. The number indicates the sample number corresponding to Table 2.1 (e.g., P021 is Number 1, etc.).

be taken because of the sample size recovered. The tree coverage values indicate that, broadly speaking, the region was forested, in the uplands and the alluvial plain, but coverage may have varied throughout the Holocene. The jigsaw-shaped phytoliths, which are formed in tree leaves, are present in several samples, most notably P023, but also in P025, P026, and a few in P010 and P024. These could either be an indication of wetter forest conditions or irrigation/water management (Tsarstidou *et al.* 2007); in essence, their presence indicates increased water availability. There are also possible fruit phytoliths as well, which could indicate horticulture in the plain or in the uplands.

While we should be cautious with interpretation due to low sample counts, the Ic (climate index) values show some variation across time but conditions are generally stable and C_3 plants dominate, indicating a temperate regime. The Fs (water stress) index reflects high water availability throughout the Holocene, but with some variation across time; water stress increases in more recent periods (Figure 2.10).

Three phytolith samples (PO42, 043, and 045) were analysed from the Yazin Tepe region, taken near the banks of the Tanjero (Figure 2.7:G14), mainly to see if there is a difference in preservation in this area as compared to the Bakr Awa area. At this point, without dating, there is no way to correlate this with the Bakr Awa sediments. Two of the samples came from sandy contexts and one from silt. The phytolith abundance was generally better than that of Bakr Awa, but the absolute numbers were still not very high, ranging from about 1000–8000 phytoliths per sample. There were very few multi-cells. The sandy deposits contained more diatoms and spicules, perhaps a reflection of overbank deposition; it should be noted that there were very few of these present in any case. Monocotyledons dominated the assemblage with more than 87%. Some jigsaw-shaped phytoliths were found, indicating that wetter forest conditions were present at some point, likely upstream. Sedges dominated the samples, with some grasses, possibly wild. Only one unidentified cereal multi-cell was found in the three slides (Figure 2.11). As mentioned previously, samples

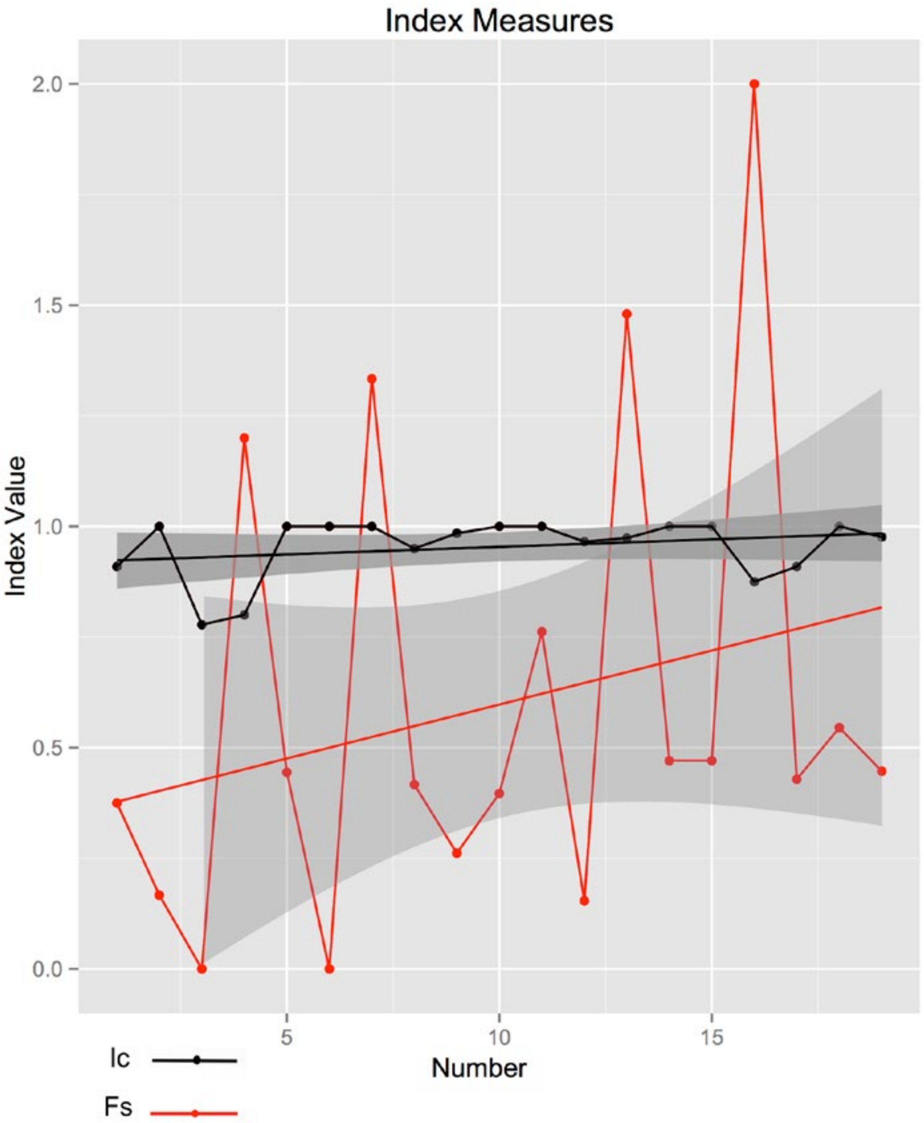

Figure 2.10. Ic and Fs indices showing climatic and water stress over time along with regression trend lines. Generally, we see more drying conditions occurring at the top of the trench and near the Achaemenid/Hellenistic sherd. The number indicates the sample number corresponding to Table 2.1 (e.g., P021 is Number 1, etc.).

were also taken from bulk sediments to search for the presence of ostracods. Unfortunately, none were found.

Results from Bakr Awa

Evidence presented here will elucidate on resource use and site economy, with some background environmental signals, which can be compared with the offsite samples. The preservation of the phytoliths is generally very good. Some samples, however, did have some dissolved, melted, or weathered specimens, and some of the cereal husks are difficult to identify to genus/species levels as a result. Samples range in date from the Early Dynastic (ED; 2900–2300 BC) Period to the Late Bronze Age (LBA; 1600–1200 BC; Miglus *et al.* 2013) and were sampled from a variety of contexts.[1]

Figure 2.11 indicates ratios of different plants present on the site and their estimated dates, based on AMS

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[1] The ED interpretation is based on an AMS date to around 2620–2570 BC, but the full range of possible dates and ceramics could push this date back to roughly the late 29th century BC (i.e., near the end of the ED I Period). Another date, ranging between 2270–2040 BC, is suggested for an Akkadian/Post-Akkadian structure, with the 22nd century BC being a likely range. An occupation gap might be present at around 1600–1400 BC in the east part of the site where samples were taken, while the site of Bakr Awa likely becomes smaller during this period (Altaweel *et al.* 2012; Miglus *et al.* 2013), but otherwise the area appears to be continuously occupied during this time.

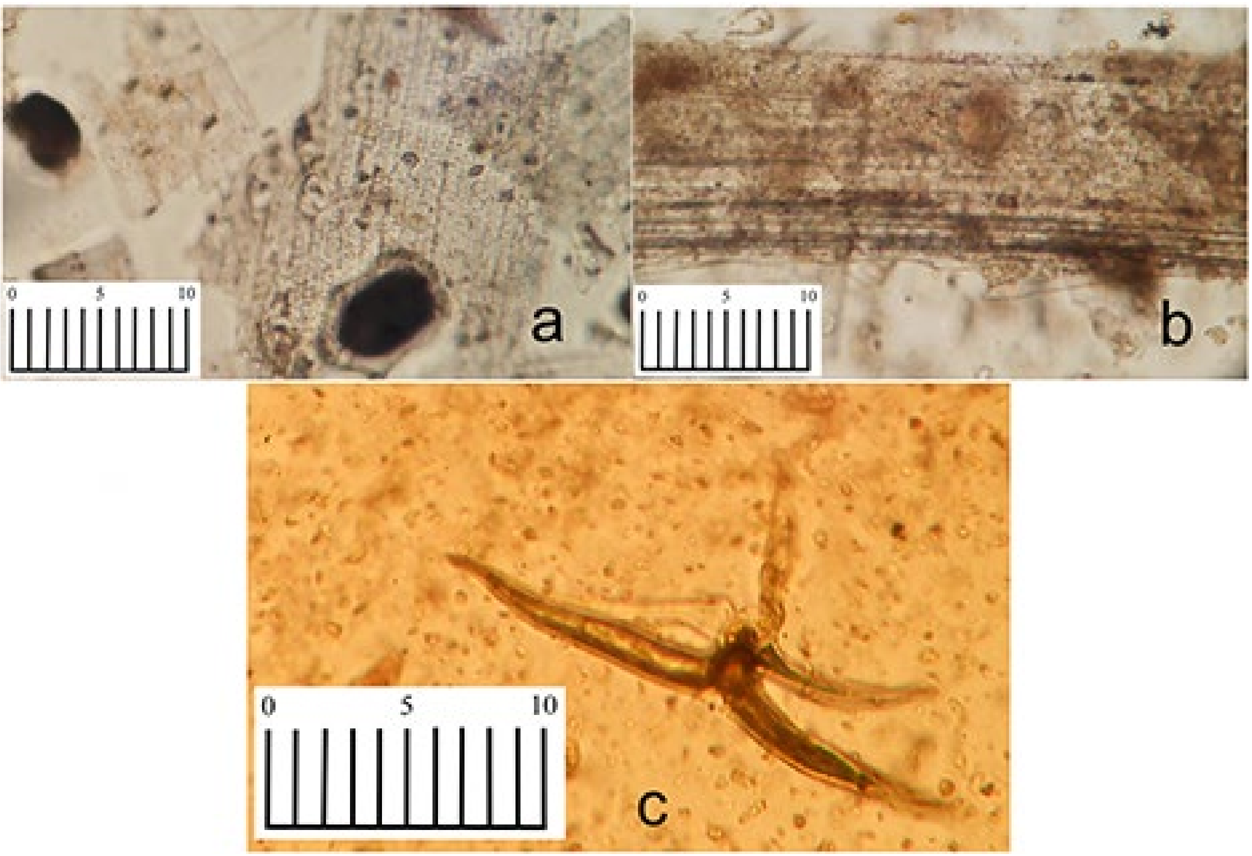

Figure 2.11. Images of microfossils from Bakr Awa samples (a: cereal husk multicell, b: grass stem multicell) and offsite samples (c: sponge spicule).

values and ceramic finds. There do not seem to be any obvious temporal trends in these samples. Generally speaking, cereals, weeds, wetland plants, and dicotyledons are all present throughout the different periods, and variance seems to be more dependent on archaeological context in which they were found rather than indicating specific environmental conditions or changing resource use. Monocotyledons (grasses) outnumber dicotyledons (shrubs and trees), which is expected as monocotyledons produce more phytoliths than dicotyledons (Piperno 2006). The dicotyledons range between 5–15%. There may be some tapering off of dicotyledon numbers in the later LBA levels; however, this is likely context related as all samples came from floors in the later LBA. Rondels (C_3 plants) also dominate the record, in all periods, and reflect the trends of the offsite samples. These likely reflect the presence of cereals on site. There are some increases in the number of saddles and bilobes in certain contexts and all periods, probably signifying context-specific use (i.e., use of wetland plants for baskets and mats). At any case, it is difficult to determine climatic signals with any certainty from onsite materials, as the phytolith record reflects material that is mostly, although not completely as in the case of weeds, intentionally brought on to the site.

Wetland plants are found throughout the existence of the site, and consist mainly of sedges, although some reed phytoliths were identified in a few samples, specifically a late 3rd millennium floor level (where the reeds may have been used for floor mats). Wetland plants were (and still are) used for baskets, bedding, mats, and/or roofing material. Overall, the relatively high presence of wetland plants indicates exploitation of these resources that were most likely found very near Bakr Awa, given the results of the offsite samples.

Dicotyledons were also found throughout the samples, but were especially high in one sample from an unidentified ‘white layer’ of pure silica, on an Akkadian/Post-Akkadian (i.e., roughly 22nd century BC) shrine pavement. The fireplace, located in the shrine, also contained wood and dicotyledon leaves and cereal and weed phytoliths, possibly indicating the use of both charcoal (wood) and dung or leaf and cereal/weeds as fuel types.

Single cells and multi-cells are both found in the samples and the multi-cells ranged between 5–50% of the total, with most ranging between 15–25%, which is far higher than in the offsite samples. Throughout samples from the ED to LBA, there are large multi-cells, mainly 10+

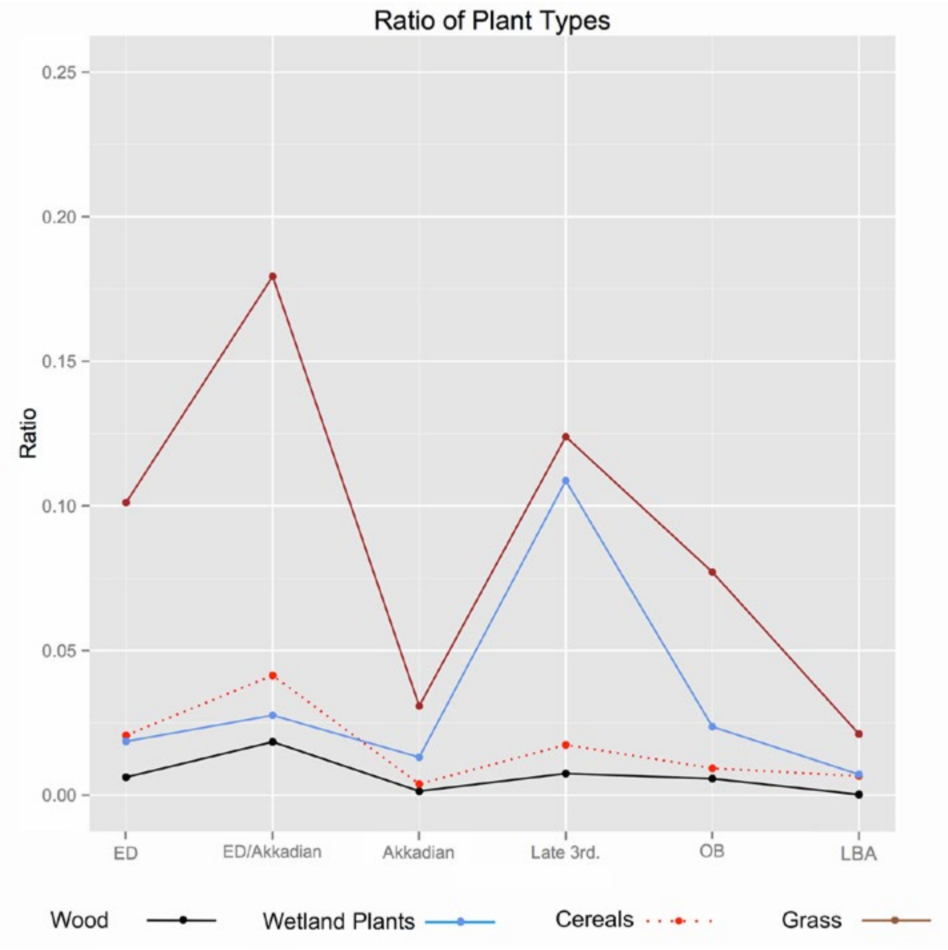

Figure 2.12. Ratios of different types of plants found at Bakr Awa and in different periods. Sample number of phytoliths range between 329,511–27,734,675.

conjoined cells, but in some cases they are larger, with over 100 conjoined cells. Due to taphonomical issues, such as crop processing, sampling, and laboratory procedures, large multi-cells such as these are very rare and their presence could indicate flood farming/irrigation (Rosen and Weiner 1994), or high water availability. This further suggests the region's relatively high water abundance. It is likely, given the geoarchaeological evidence, hydrologic conditions, as well as the index results on the offsite samples for high water availability, that flood farming/irrigation was practiced from at least the early 3rd millennium BC until roughly 2300 BP.

As Figure 2.12 shows, only barley is found in the ED Period; however, this could be because the overall sample is relatively low for the ED. Wheat and barley are then found throughout the Akkadian Period, but by the late 3rd millennium BC, again there is only barley. During the Old Babylonian (2000–1600 BC; OB), which was the best-represented period in the samples, both barley and wheat are present, with only wheat represented in LBA samples. In general, barley dominates most samples. The results could be biased because of sample size and poor preservation of multi-cells. There appears to be no covariance between straw and cereal husks. Barley appears to covary with agricultural weeds especially from the ED to the OB, and there is also fairly strong positive correlation between the two (*r*=0.93), possibly indicating that it is a weed or a wild type being used as fodder (Ryan 2009). Additionally, it seems that only the barley came in together with weeds, showing that less effort may have been taken to remove weeds from barley. There is a weak correlation between wheat and weeds (*r*=0.69), which may suggest separation of weeds from wheat, as well as between wheat and barley (0.78). Straw was also found in most of the floor contexts. These come from different floors and might be indicating domestic activity revolving around the processing/storage of cereals.

Similar to the offsite samples, diatoms are present in small numbers in most of the samples, and sponge spicules are found in one of the samples. Most of the diatoms are pennates, in many cases *Hantzschia amphyoxis*, which is a terrestrial species found on

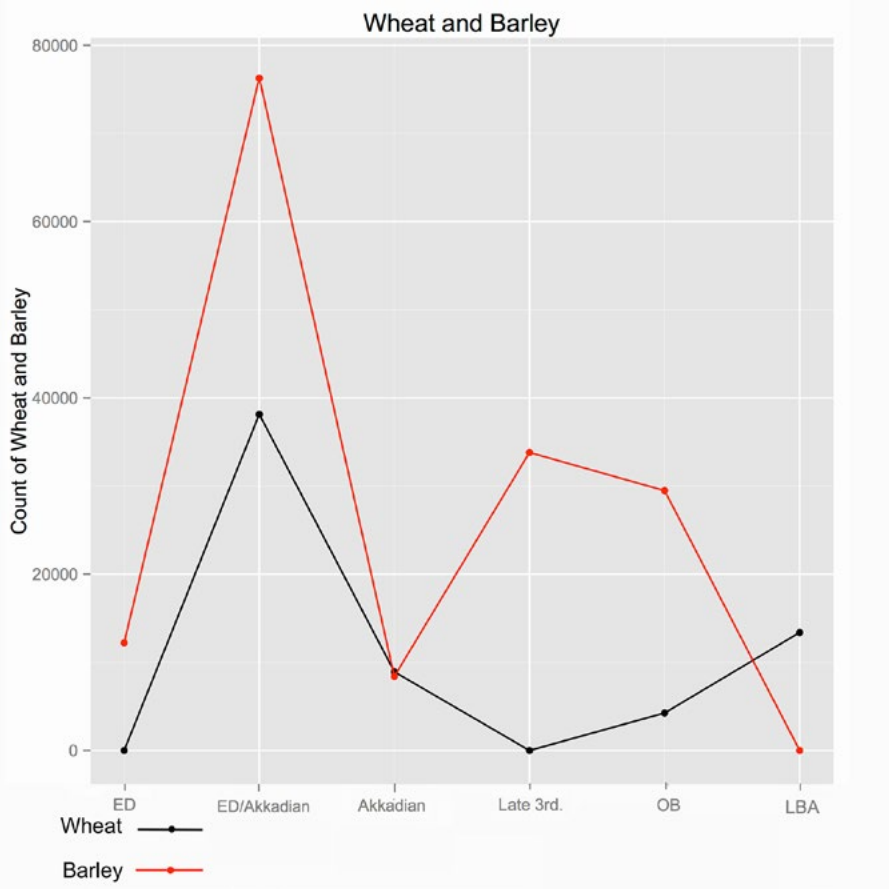

Figure 2.13. Number of wheat and barley phytoliths from samples and different periods.

mosses. In two samples there are centric forms. The diatoms are most abundant in one sample, which comes from an Akkadian/Post-Akkadian Period (22nd century BC AMS date; Miglus *et al.* 2013) fireplace near the shrine. There is very little covariance between wetland plants and diatoms, and no correlation (*r*=0.28), which probably indicates that they did not come into the record together. There was very little charcoal in the samples; however, there were some burnt and even melted phytoliths in many samples, indicating burning and high temperatures in the vicinity of those contexts.

Speleothems

While speleothem studies have mostly focused on Northern Turkey (Badertscher *et al.* 2011), the Levant (Bar-Matthews *et al.* 1997), and the Southern Arabia Peninsula (Fleitmann *et al.* 2003), work in Iraqi Kurdistan, specifically from Kuna Ba cave near Darband-i Khan village and lake with the same name, has begun to use these proxies to reconstruct climate (Reuter *et al.* 2012). The speleothem record begins from 1500 BP and shows that there has been a general trend of desiccation for longer periods, with the years between AD 700–900 and 1100–1700 in particular being relatively dry. Additionally, the signals do not correspond well to the Little Ice Age (LIA) and Medieval Warm Period (MWP), or North Hemisphere temperature anomaly, indicating that local conditions could have been different from larger climatic trends and emphasising the importance of local climate proxies rather than those that are distant. Considerable precipitation variability from year to year is evident, specifically in 5–20 year cycles, even though the long-term trend is not drastically different than today's conditions, with only 1.3% variability from proxy records. These results generally agree with what is found in the sedimentary record that shows soil formation happening during the later parts of the Holocene (i.e., after 2300 BP) and until recently, as alluviation, and thus hydrologic flow into the Shahrizor valley, diminished in areas we have investigated. This likely indicates generally less discharge and wadi or small river systems diminishing and becoming more seasonal as the climate has become drier over the last 2300 years.

Discussion and conclusion

We have presented information on current and past Holocene environmental conditions. To summarise, the sedimentary sequence suggests that alluviation and increased hydrologic flow, relative to today, once characterised the Shahrizor region, particularly from the earlier parts of the Holocene to before 2300 BP. Large alluvial channels once cut across the landscape, carving out much of the Pleistocene topography, leaving some parts of the terraces more elevated and exposed, where archaeological sites, including Bakr Awa, are commonly seen today. The sedimentary record also indicates that many sites, which did not occupy the more elevated Pleistocene terraces, might be buried under metres of sediments. Generally, our sections in the Bakr Awa and Begum region indicate an area of frequent channel cutting and erosion, followed by deposition of fine-grained sediment. The modern topography reflects, for the most part, the deposition patterns followed during the Holocene. There also appears to be multiple channels active at possibly the same time in these regions, suggesting water flow abundance, where anabranching stream systems, that is composed of multiple active channels which avulse across a section of the plain, being characteristic of part of the region (i.e., Bakr Awa). In addition, because the sediments often contain a large percentage of clay content and do not exhibit the usual fining up sequences found in channel deposits, it is possible that these channels are cut off chutes, or channels created during flooding events, which were then cut off shortly after creation, filling up subsequently with silts and clays (Brown 1997), as floodplain deposits. The sediment colours, including the mottling present in some of the layers, indicate that the sediments went through periods of dryness and waterlogging. This supports the idea that the channels seen in the deep trench for instance were more likely cut off chutes or flood channels, secondary to a larger channel elsewhere. At Begum and Yazin Tepe, sediments are more similar to overbank deposits, and seem to reflect changing channel positions, representative of more meandering river systems.

After about 2300 BP, there is a hydrological change, which is also reflected in the speleothem record, indicating increasing aridity in the region. While the Shahrizor is still a relatively wet region, the implication of this on local cultures and economies is that there may have been changes in agricultural and husbandry strategies; for instance, a switch from flood/irrigation farming (e.g., seen at Bakr Awa in the 3rd to 2nd millennium BC) to more reliance on dry farming and certain crops requiring less water. In addition, deforestation in the region would also have influenced the water budget, sedimentation, and microclimate in the region, exacerbating any possible drying trends after 2300 BP.

A mosaic of landscapes and vegetation are likely to have existed for much of the Holocene in the Shahrizor. We see strong evidence of wetland plants in many phytolith samples, both at Bakr Awa (on and off site) and Yazin Tepe, from different parts of the Holocene. Most of the early to late Holocene vegetation, in fact, suggests a region with riparian woodlands and wetlands, alluvial plains and upland forests, with only a minor remnant of the forested areas remaining today. Much of the Holocene was relatively temperate, given the evidence of C_3 grasses. Phytolith data suggest, in general, a high presence of water, continuing until at least until the late 1st millennium BC. However, considering the presence of large alluvial channels, only parts of the plain, specifically the better drained areas along the upward slopes of Pleistocene terraces, would have been more ideal for grain agriculture. Additionally, both charcoal and dung resources were utilised for cooking and other fire-related activities, with wood likely to have been used as building material. Wetland plants, such as reeds and sedges, appear to have been exploited at Bakr Awa, utilising local resources. Fluctuations in crops in the region are suggested by the phytolith results, but this does not appear to correspond to any clear climatic signals and could just be a result of limited sampling or crop preference. Interestingly, greater or exclusive use of barley in the late 3rd millennium BC period from Bakr Awa does parallel events in Southern Mesopotamia, where barley was also becoming the grain of choice (Jacobsen 1982; Maeakawa 1984). This could reflect an economic focus toward barley used for animal fodder, rather than climatic change, as the Shahrizor was possibly very important for wool production and animal husbandry in the late 3rd millennium BC and Ur III Period (Stone 2014). The presence of weeds in barley at Bakr Awa suggests its use for animal fodder rather than human consumption. Plant exploitation also appears to utilise weedy barley, which further highlights the possible use of these grains for fodder or there was some general preference for such grains that may have required less agricultural input for production. For other sampled periods, excluding the ED, we see mixed use of wheat and barley or exclusive use of wheat, specifically in the LBA. Fruit cultivation is also evident in samples taken on- and offsite.

While the change in the landscape over the last 11,000 years has been undoubtedly affected by anthropogenic activity, climatic shifts are also evident. We would characterise that much of the Neolithic through the mid-1st millennium BC as a period of relatively stable and greater water abundance in contrast to today, possibly suggesting no major or long-term drying episode during that time. Continued and long-lived sites in the Shahrizor (Directorate General of Antiquities 1970; Altaweel *et al.* 2012) during the 3rd to 1st millennium BC suggest favorable climatic conditions for the mid to late Holocene, but there does seem to be a cultural transition or some level of site abandonment by around 1600 BC with the arrival of the Shamlu culture. Any climate relationship to this is not currently evident. We would characterise that much of the Neolithic through the mid-1st millennium BC as a period of relatively stable and greater water abundance in contrast to today, possibly suggesting no major or long-term drying episode during that time. In fact, major temperature or climate anomalies that agree with larger global trends, including the 4.2 kiloyear event (i.e., often associated with the collapse of the Akkadian empire; Kerr 1989; Kaniewski *et al.* 2012), MWP, and LIA, have yet to be evident in the Shahrizor, which emphasises the need for collection of local proxies. While dated samples from Bakr Awa do not suggest the 4.2 ka event had a major impact in the region or even wider region, the results emphasise the need for collection of local and multiple proxies rather than assuming other, distant or singly proxies are indicative of regional environmental trends. Only by building up a good set of local proxies will we likely have a better and clearer understanding of the regional palaeoenvironment. Speleothem proxy results and dates provided show that global climate trends did not necessarily have major effects on the immediate region. Sometime during the last 2300 years, and particularly by 1500 BP, there is strong evidence of increased drying and long-term drying phases, indicated by both the soil formation and decreased alluviation seen in the deep trench at Bakr Awa, and the speleothem from Kuna Ba cave. This increased drying does not indicate any catastrophic desiccation, as conditions may have simply become relatively drier but still sufficient for rainfed agriculture. Year to year volatility in rainfall is seen in the speleothem record, but the millennial trend is somewhat similar to today's conditions. The presence of Parthian through late Islamic sites does not suggest any major settlement abandonment in the region (Altaweel *et al.* 2012), but the site survey record is not yet complete.

Certainly more work is needed to refine our understanding of past land use and climate in the region, with particular focus on more refined and better dated contexts. This has begun by the collection of phytoliths from dated contexts or at least datable contexts, while our speleothem work is currently monitoring two caves (i.e., Kuna Ba, located near Darband-i Khan village, and Shelli cave (35° 8'47.70"N 45° 17'47.28"E), where a more continuous Holocene climate record appears to be available. Additionally, sedimentary collection and geophysical analysis will allow us to reconstruct the relatively early Holocene topography and have a greater understanding of alluvial change in the region during most of the Holocene. This could also give us a sense of the location of palaeochannels and places where likely agriculture would have taken place.

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Social Life and Social Landscapes Among Halaf and Ubaid Communities:
A Case Study from the Upper Tigris Area

Marco Iamoni

Settlement patterns and related types of investigation (e.g., site densities, site dimensions and land-use) have in the last 50 years shed light on a number of archaeological issues previously underestimated or ignored by archaeologists. By means of survey projects it has been possible to reconstruct several crucial aspects of the archaeology of the Ancient Near East. A major consequence has been a growing awareness of the landscape as a fundamental subject for modern archaeological research, of great significance for understanding ancient complex societies, especially from the 3rd millennium BC onwards (Adams 1981; Adams and Nissen 1972; Smith 2014; Wilkinson 2003). Pre- and proto-historic periods have received somewhat less attention, probably due to the absence of solid and well-established human communities that acted on the surrounding landscape by exhibiting the traditional markers of 'complexity' common in later periods, e.g., hierarchy, power, and prestige, (Smith 2014; Wilkinson *et al.* 2005)[1].

Using the Upper Tigris as a case study and investigating it by means of statistical analyses I intend to explore the possible occurrence of a 'social landscape' as far back as the 6th and 5th millennium BC, in this area associated with the Halaf and Northern Ubaid Periods. I propose that societies with a lower level of socioeconomic complexity still had an impact on the territory and worked, perhaps unintentionally, to modify it. The outcome of such modifications might have been different and indeed visually less clear and direct than those created by later and more complex entities, but were likely perceived by the inhabitants of the landscape and are still visible today, though their identification requires a more subtle investigation of the evidence still visible in the landscape.

Two opposite types of society? Chronology and socioeconomic dynamics during the Halaf and Northern Ubaid

The Halaf and Northern Ubaid are the periods commonly adopted to describe the types of settlement, economy, and social structure that characterise the late Neolithic and early Chalcolithic in Upper Mesopotamia between the 6th and the mid-5th millennium cal. BC. Both have reasonably well-defined traits that are especially evident in their ceramic material culture (Akkermans and Schwartz 2003: 101), and actually, as has been already observed, they might perhaps be more adequately referred to as ceramic traditions, rather than real 'cultures' (Campbell 2007: 104–105). Their origin from old assumptions (ultimately depending on an outdated culture historical approach) has been rightly criticised as bearing little relation to the real social developments of the Late Neolithic and Chalcolithic (Akkermans 2013c; Campbell 2007). As a consequence, the Halaf/Ubaid periodisation may even represent, to some extent, an obstacle in our attempts to comprehend the phenomena characterising Upper Mesopotamia throughout the 6th–5th millennium BC.

Yet, despite this criticism, the absence of a proper counter-proposal for a new periodisation, such as that proposed for the Late Chalcolithic and Uruk Period (see Rothman 2001), makes it necessary for the present work to retain the classic Halaf and Ubaid subdivision, where the Halaf is characterised by the well-known decorated pottery and typical *tholoi* architecture (Bernbeck and Nieuwenhuyse 2013) and the Northern Ubaid, a late development of the Southern Ubaid culture (Akkermans and Schwartz 2003: 154; Stein 2010: 33–34), features the classic monochrome painted pottery as well as domestic architecture with tripartite/cruciform planning.

The Halaf Culture spread into Upper Mesopotamia at the turn of 7th–6th millennium BC (Bernbeck and Nieuwenhuyse 2013: fig. 1.3) and covered a very large area extending from the Western Taurus, where it coincides with the Amuq C and D phases known from the excavation at Tell Kurdu (Braidwood and Braidwood 1960: 137–138; 157–158), to the Tigris and Euphrates river basins. Despite significant internal differences in access to technological knowledge, notably evident in pottery production (Campbell 1995: 74–75), as well as of clear indices of craft specialisation and/or limited access to stored goods, the most recent studies based on updated research suggest that Halafian societies were largely egalitarian (Akkermans 2013c: 29; Akkermans 2013a: 72). Similarly, Halafian settlement does not seem to show any clear evidence of hierarchy

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[1] For a clear case study, see the systematic and strategic manipulation of the landscape carried out by the Assyrian kings during the 1st millennium BC with the carving of monumental reliefs such as Khinis and Maltai, typical of the imperial propaganda (Morandi Bonacossi 2018; Reade and Anderson 2013).

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(Akkermans 2013a), with a striking majority of the Halaf sites showing a general tendency to be of small dimension (1–2 hectares). The evidence is admittedly inconsistent, since a few sites, such as Takyan Hoyük, Nisibin/Qamishli and Domuztepe (Algaze *et al.* 2012: 15; Campbell *et al.* 1999; Nieuwenhuyse 2000), apparently reached considerable size (10 hectares or more). This has been suggested to represent settlement hierarchy (Campbell and Fletcher 2013; Iamoni 2016; Watson 1983), perhaps emerging at the end of the Halaf Period (Akkermans and Nieuwenhuyse 2019). It is possible that such hierarchies may have characterised specific sub-regions of Upper Mesopotamia, in a landscape otherwise dominated by small rural settlements.

The Northern Ubaid culture dates from 5300 to 4500 BC (Stein 2012). Although in its primary and most essential classification it can be considered as the result of the diffusion of a ceramic tradition developed in Southern Mesopotamia, in Upper Mesopotamia this has occurred together with the emergence of clear traces of socioeconomic complexity exemplified in the presence of a hierarchical society with an elite ‘ruling’ the settlement (Carter and Philip 2010: 10–13). Further innovations suggest the existence of more stable long-distance contacts and the clear presence of two-tier settlement hierarchy, as well as an intensification in the exploitation of domesticated animals and plants (Stein 2012: 128–129), though at present there is no clear evidence of irrigation systems for farming activities (Akkermans and Schwartz 2003: 173).

The two periods seem to be contrasting in many respects, yet the most recent investigations do not suggest any abrupt change and point to the occurrence of a smooth transition, the so-called Halaf–Ubaid transition, henceforth HUT (Karsgaard 2010), exemplified in the Tepe Gawra sequence (Stein 2010: 34–37; Tobler 1950). The emergence of the Northern Ubaid in Upper Mesopotamia has been seen as a peaceful expansion of Southern Mesopotamian cultural identity into pre-existing local Halafian communities (Breniquet 1987). However, the dynamics and processes that led to the spread of the Northern Ubaid are still in many respects a *terra incognita,* and it is to be hoped that the HUT will be a research subject of major importance for the next archaeological projects in the region.

Much archaeological research has, to some extent reasonably, focused on excavated site sequences (e.g., Tell Sabi Abyad for the Halaf and Tell Zeidan for the Ubaid Periods) as the main source of information for understanding Halafian and Ubaid societies. Less attention has been given to the different modes of land exploitation as well as to the distribution of sites and the possible relationships of the latter with the different types of societies and economies that characterise the Halaf and the Northern Ubaid.

The Upper Tigris is a suitable case study to begin such an investigation. Broadly speaking, this region extends west to east from the Jebel Sinjar to the Jebel Bashikah and north to south from the area of Mosul to the lower fringes of the Zagros mountains (see Figure 3.1). The region has been the subject of several survey projects (in particular the North Jazira Survey, henceforth NJS, carried out by Tony Wilkinson and David Tucker) as well as salvage excavations: taken together these provide a large and valuable corpus of information. Tony Wilkinson’s activities in the area make it a fitting choice for this volume, and our article here represents a thank you for the availability of information that Tony has given to the scientific community with his many projects in Upper Mesopotamia.

The Upper Tigris areas: source of data

The Upper Tigris received only occasional attention from archaeologists until circa 40 years ago (Iamoni 2014a) when the construction of the Saddam Dam Basin — since renamed the Eski Mosul Dam — threatened to flood a number of sites located along or next to the river course. Despite the high number of sites involved, these salvage excavations (Iraqi Minister of Culture and Information 1986) produced a patchy array of data, due to the lack of final and adequate publications of the excavation results in many cases. Previous research demonstrated the relevance of the area for archaeological investigations of pre- and proto-historic periods (e.g., Arpachiyah and Gawra, excavated during the 1930s); however, the presence of the great Assyrian capitals (Khorsabad and Nineveh above all) attracted the archaeologists’ attention and left the Upper Tigris area in a marginal position with respect to the excavation projects. With regard to survey activities, the rich archaeological potential preserved in the area has been investigated only on the western side of the Tigris, thanks to the above mentioned NJS, as well as to the investigations carried out by the University of Edinburgh in the region of Zammar and the Tigris Euphrates Reconnaissance Project (henceforth TERP) directed by Guillermo Algaze. Pioneering investigations had been carried out by Seton Lloyd in the late 1930s with the Sinjar Survey (Lloyd 1938), whose results, though based on a limited knowledge of the material culture of the area (especially with regard to the Late Chalcolithic and 3rd–2nd millennium BC), offer good evidence for the Halaf and Ubaid Period. The greater reliability of the latter periods was possible thanks to a better knowledge of the ceramics — defined in the report as Group II and III (Lloyd 1938: 132) — derived from the almost contemporary publications of excavations results at Arpachiyah and Nineveh (Campbell Thompson and Mallowan 1933; Mallowan and Rose 1935).

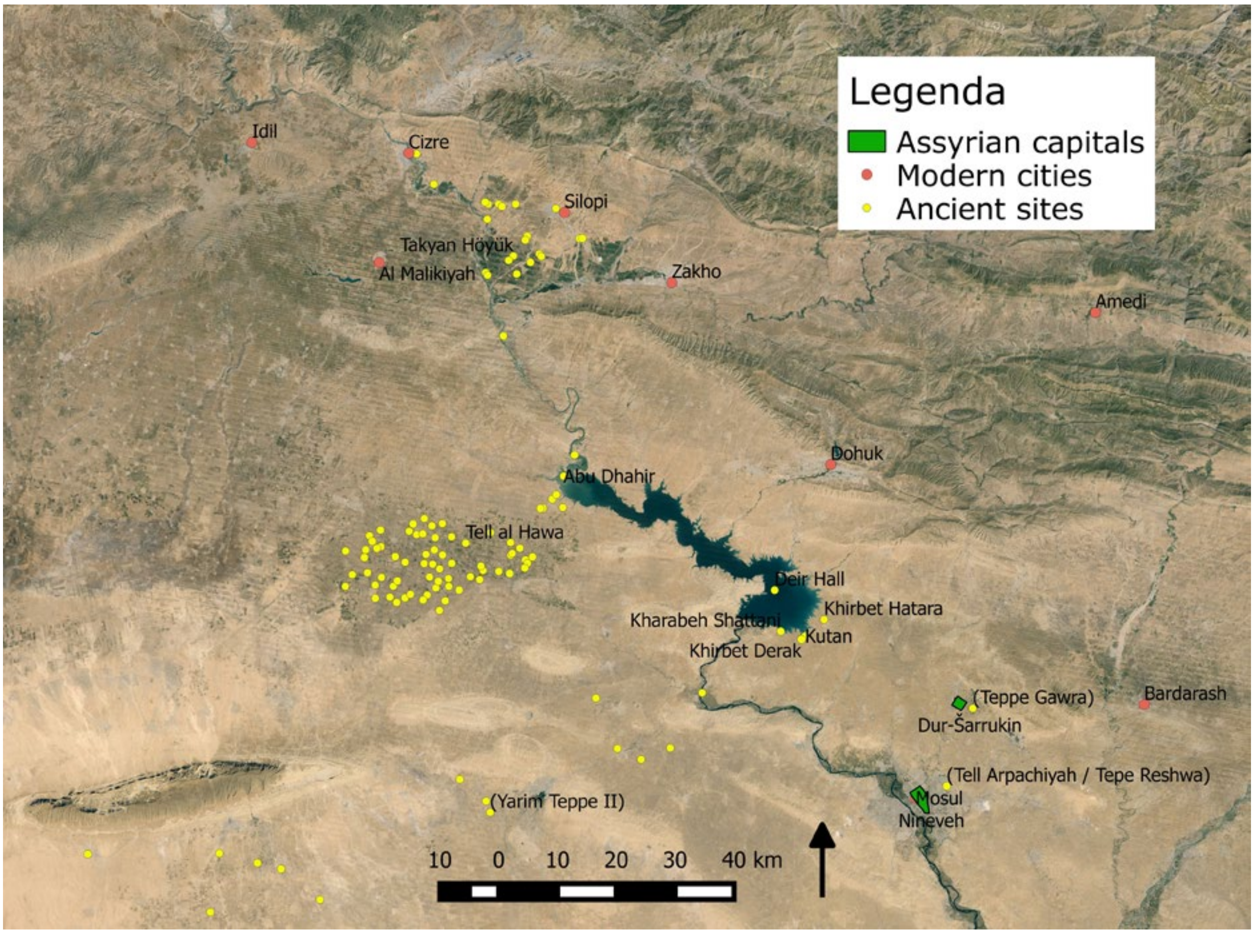

Figure 3.1. The Upper Tigris Basin with the sites mentioned in the text. Basemap created by the author with QGis, using Google Earth satellite images.

Iraqi investigations have also been undertaken, especially after the salvage excavations for the Eski Mosul Dam: unfortunately the two Iraqi wars have seriously hampered the progress of the research in the area and only partial summaries of the achieved results have been published (Altaweel 2006; 2007).

The combination of the survey data (NJS, TERP, Zammar area and Sinjar Survey) makes a corpus that, although derived from a discontinuous and patchy coverage of the area, from preliminary publications of the results and, last but not least, from investigations that differ sometimes significantly in methods and techniques, offers a consistent starting point to carry out a regional analysis of settlement patterns in the Upper Tigris basin. The area is suitable for undertaking such a comprehensive research study due to the relative homogeneity of the physical landscape and environmental conditions: it falls well above the 200 mm rainfall isohyet and is characterised by a flat and fertile plain crossed by regular seasonal *wadis* (Wilkinson 2003: 17). It therefore offers good conditions for stable human settlement.

The dataset includes 162 prehistoric sites, of which 112 were occupied during the Halaf and Northern Ubaid phases. This forms the key dataset for the settlement analysis; information from single excavation sequences (e.g., Gawra) will be occasionally used to integrate the results achieved. As will be shown below, this investigation can provide an alternative insight on territorial settlement throughout the Halaf and Northern Ubaid Periods, thus roughly across a thousand year period (mid-late 6th and mid-late 5th millennium BC). It will also further help in understanding the HUT phenomenon, which, as said above, is of crucial importance in the changes that eventually led to the full explosion of socioeconomic complexity during the Late Chalcolithic with the rise of urban societies.

The Upper Tigris area during the Halaf Period

The sites occupied during the Halaf Period are 60 in total. The regional settlement shows a slight increase if compared with the previous periods (Iamoni 2014a), but no site hierarchy emerges clearly. Although the emergence of sites of remarkable dimensions during the

Halaf Period has been proposed at sites like Domuztepe, Kazane, Mounbatah, and Tell Badan/Nisibin (Campbell and Fletcher 2013: 42–43) and in the Beydar Survey (Nieuwenhuyse 2007a: 294), this has been contested (Akkermans 2013a: 71; Bernbeck 2013: 57) and it seems that the real extension of the Halaf settlements is still a matter of debate.

In the Upper Tigris, the only site that has apparently provided a significant occupation is Takyan Höyük, whose 10 hectare size and central position with respect to a series of 'minor' settlements (Algaze *et al.* 2012: 15) allows us to hypothesise the existence of some kind of predominance in the territory. Yet Takyan Höyük is an exception in the area under examination, with the above-mentioned large Halaf sites lying further to the west, from the upper Syrian Jazira to the southern edges of the Taurus Mountains. This fact is quite significant since relevant Halaf sites are also found in the Upper Tigris area, such as Arpachiyah (Mallowan and Rose 1935) or Tepe Gawra (Tobler 1950), and these do not seem to cover extensive areas: none of them reach more than 2 hectares. The small size of these settlements is somewhat striking, especially if one considers the role that Arpachiyah might have had in the light of the considerable wealth of finds retrieved during the excavation. The amount of polychrome pottery, seals, obsidian artifacts and pendants found during the excavation of the Burnt House of level TT6, the last level before the Ubaid occupation of the area (Campbell 2000), suggests that the residents of Arpachiyah had developed a high level of craftsmanship, which, in turn, is difficult to explain with the socioeconomic model of a small village (but see for a similar evidence from a small settlement the case of Sabi Abyad, Akkermans 2013b; Akkermans and Duistermaat 1997).

If Arpachiyah was a centre of some importance, its nature had to be different from the big sites of Southeast Anatolia/Northern Syria (Campbell 2000: 25). Its small dimensions suggest a minor relevance as 'reference' centre for the surrounding territory. At the same time, the presence of high value artifacts in its Halaf assemblages suggests that settlement size might not be directly correlated with the degree of labour specialisation. This is not the place to tackle this topic in more detail, which would require a dedicated work based on significant evaluation of excavation data: a preliminary consideration, however, suggests that small site dimensions may not necessarily imply absence of significant technological complexity.

At the same time, it is interesting to observe that the large Halaf settlement at Takyan Höyük, if confirmed, finds significant parallels in other large concentrations of Halafian population located further west, such as Nisibin (Nieuwenhuyse 2000), and thus may support the idea of large settlements starting to rise already during the early and mid-6th millennium BC. Further, Takyan Höyük suggests that these big Halaf sites were not restricted to the central and western regions of Upper Mesopotamia but occurred also in the eastern area as well (e.g., the Tigris Basin).

The striking majority of the Halaf sites are, however, of small dimensions. In the NJS these range from 1 to 2.5 hectares (Wilkinson and Tucker 1995: fig. 32) whereas in the TERP they are even smaller, with an average size of 1 hectare (Algaze *et al.* 2012: 15–16).

The Halaf settlement pattern is quite important, as it is the first time that there is consistent evidence of sites being located far from watercourses. This is particularly clear in the NJS areas (a rough estimation based on Wilkinson and Tucker 1995, fig. 36, suggests a maximum distance of about 1 km for both Hassuna and Halaf sites), whereas in the Northern Tigris valley they continue to occur in well-watered areas, though also there they are apparently less dependent on stable rivers (Algaze *et al.* 2012: 16; Wilkinson and Tucker 1995: 40). The latter aspect is of particular relevance for two reasons. First, it highlights the capacity for accessing water independently from the direct availability of natural sources (e.g., through the construction of water wells). Secondly, it may imply an element of continuity with the previous Neolithic settlement pattern: a few NJS sites are located far from water sources as well (although see the TERP evidence where such pattern has not been identified: Algaze *et al.* 2012: 13–14).[2] This will be an important point for future research, as it further reinforces the interpretation of the Halaf culture as a direct continuation of the preceding ceramic Neolithic (Akkermans 2013c) and not as an innovation generated by the arrival of new people (Mellaart 1975).

The most interesting information comes from the distribution of the Halaf settlements in the area. Contrary to previous observations, where a general dispersion of sites had been proposed as the main trait characterising the Halaf settlement pattern (Akkermans and Nieuwenhuyse 2019; Wilkinson and Tucker 1995: 40), the wider picture emerging from the integration of more survey data suggests some clustering of sites in specific areas. The best evidence comes from the NJS area, thanks to the higher number of surveyed settlements, but similar evidence can also be seen in the TERP and, to a much lesser extent, in the excavation carried out in the salvage projects around the Eski Mosul Dam.

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[2] It must not be forgotten that, despite the regional general homogeneity above stressed, there might be local geographical differences that have affected the settlement patterns and brought about these differences between the NJS and TERP.

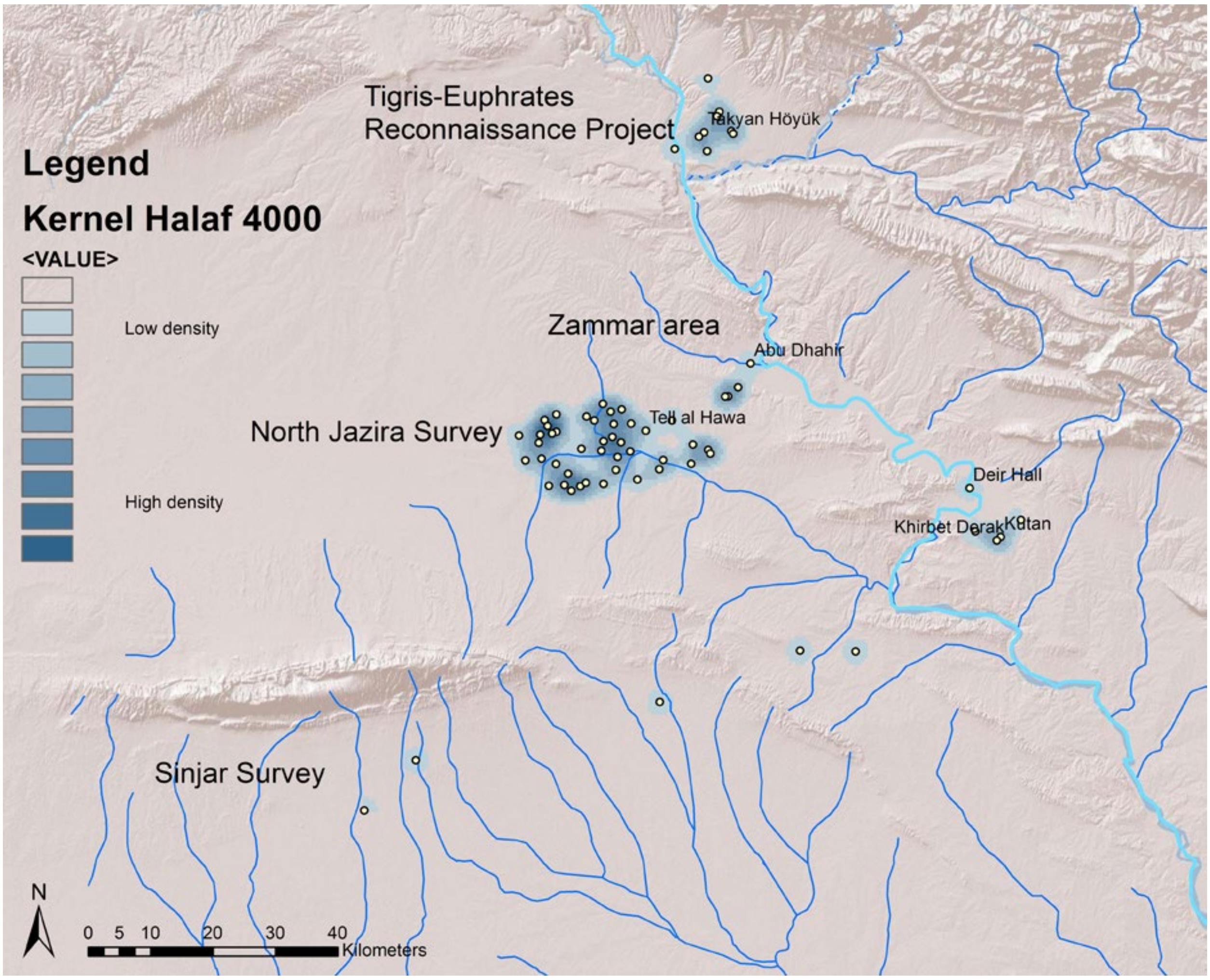

Figure 3.2. KDE with a radius set at 4000 m of the Halaf settlement in the Upper Tigris region. Basemap by the author, using ESRI Topographic Data [Creative Commons]: World Shaded Relief and World Linear Water. Shape file of the Iraqi rivers freely downloaded from www.diva-gis.org/gdata/.

The relevance of such clustering can be evidenced via a statistical test, the so-called Kernel Density Estimates (KDE). The latter is a test of density of points, which uses a specific function, the 'kernel' (Baxter and Beardah 1997), to evidence areas of increasing site concentration and consequently settlement aggregation (Conolly and Lake 2006: 175–177; Wheatley and Gillings 2002: 166). KDE is particularly useful in GIS applications, since it is able to visualise the density estimation sometimes hidden by large numbers of sites (McMahon 2007). Due to the impossibility of knowing the exact amount of retrieved pottery in each body of data, for the following analysis the dataset has been 'synthesised' into a simple presence/absence of ceramic assemblages dating to the relevant periods, so as to make the sample analysable. This is not the ideal situation for KDE, which works better with quantitative sources of data (Shennan 1997: 29–30). However, the latter method has the benefit of focusing the analysis on the sites themselves, rather than on the quantity of surveyed pottery, the occurrence of which, especially in pre- and proto-historic periods, can be substantially altered by later occupation and re-deposition (see below for a more detailed discussion of this issue).

The results obtained by KDE analysis are very promising (Figure 3.2), since they highlight the occurrence of quite clear groups of sites: the darkness of the colour is created by the so-called 'bumps' (Wheatley and Gillings 2002: 166) of the kernel function, which is based on a radius in this case of 4 km, corresponding to a circa one hour walk, though the latter can be specified with a higher or lower number according to the level of detail that one aims at investigating. Darker colours indicate a higher density level.

The area shows the occurrence of diverse Halaf 'clusters' of population, each of which is composed by different number of sites (this is affected by the number of surveyed Halaf sites in each area). The best evidence

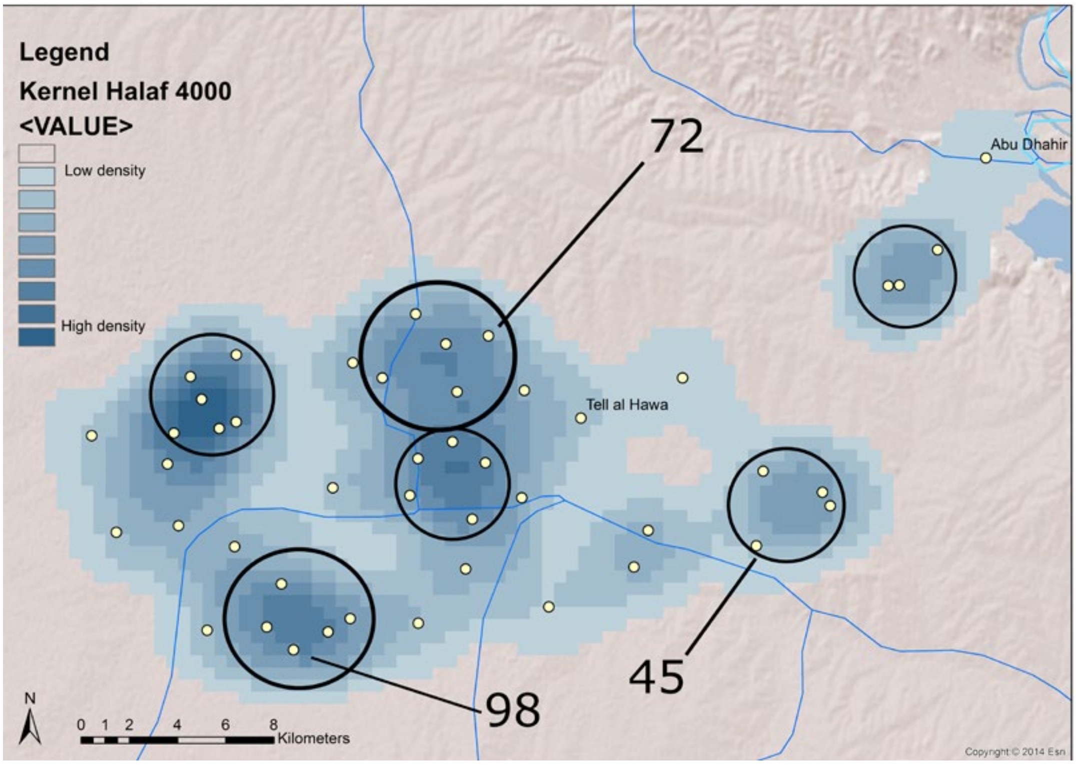

Figure 3.3. Close-up of the KDE of Halaf settlements in the NJS area with the site clusters highlighted by the author with black circles. NJS site numbers with relevant Halaf occupation, i.e., with early and late occupation, are indicated. Basemap by the author, using ESRI Topographic Data [Creative Commons]: World Shaded Relief and World Linear Water. Shape file of the Iraqi rivers freely downloaded from www.diva-gis.org/gdata/.

comes from the NJS thanks to its higher number of Halaf settlements, but interesting results also come from the TERP area as well as from the Eski Mosul dam.

In the latter two areas, site clustering is recognisable around Takyan Höyük (though the site does not seem to be at the centre of the area) and in the Khirbet Derak/Kutan area. The Halaf Period is consequently characterised by an apparent tendency to form clusters of settlements in selected zones.

It is unclear at present whether any specific site might have been an original centre around (or maybe from) which Halaf communities spread and settled. Yet it is worth noting that among the four NJS sites with long Halaf occupation, i.e., with early and late Halaf sequences (Wilkinson and Tucker 1995: 40), only one of these (n. 98) seems to be positioned in a quite central location with respect to the cluster highlighted by the KDE analysis, whereas two (n. 45 and 72) are part of the groups of sites (Figure 3.3). In the TERP region a similar case of site-centrality from which smaller Halaf settlements might have spread could also be seen in the above-mentioned case of Takyan Höyük, which also features earlier substantial occupation (Algaze *et al.* 2012: 13). In this picture we miss completely the role of the two main NJS mounds, Tell al Hawa and Tell Samir, whose major later occupations (with thick levels dating to the 3rd millennium BC–1st millennium AD) have entirely obscured prehistoric settlements, a well-known survey problem for earliest settlement. Tell Samir in particular, might have been of some relevance due to its position next to one of the Halaf groups of sites.

Similarly, Halaf pottery is present in residual contexts at other large mounds such as Tell Brak (Mallowan and Rose 1935: 244–248; pl. LXXIX): this might suggest the presence of further large Halaf settlements obscured by later phases of occupation.

The Upper Tigris area during the Northern Ubaid Period

The Ubaid settlement of the area under analysis shows traits quite different from the previous period (Figure 3.4).

The number of settlements shows an increase with a total of 83 sites now settled, which is especially evident in the TERP area, whereas the NJS shows a similar trend though with smaller proportions (Algaze *et al.* 2012: 16–

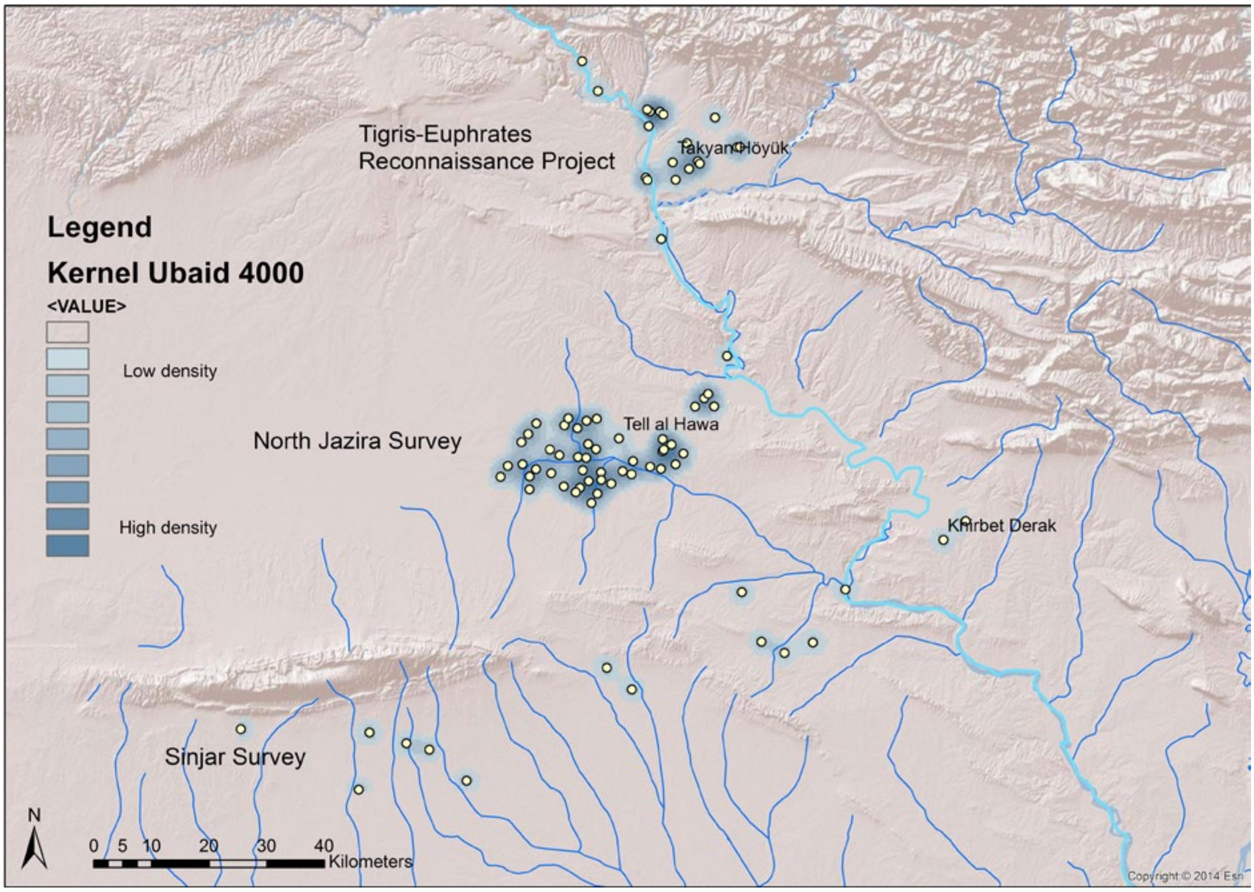

Figure 3.4. KDE with a radius set at 4000 m of the Ubaid settlement in the Upper Tigris region. Basemap by the author, using ESRI Topographic Data [Creative Commons]: World Shaded Relief and World Linear Water. Shape file of the Iraqi rivers freely downloaded from www.diva-gis.org/gdata/.

18; Wilkinson and Tucker 1995: 40). There is also a clear increase in the number of sites south of the Jebel Sinjar, with a wider coverage of the region that goes from the southern foothills of the mountains to the western edges of the Tigris valley.

Site dimensions are somewhat similar to those of the Halaf Period, with only a few sites reaching 5 hectares in the NJS (Wilkinson and Tucker 1995: fig. 32) whereas in the TERP area no site emerges as major centre of the region. Excavations and survey along the Zammar and Eski Mosul Dam basin have revealed significant Ubaid occupation at Khirbet Hatara and Abu Dhair (Fiorina 1997; Simpson 2007), but none of them revealed the presence of large settlements. On the contrary the excavated structures were domestic and similar to those identified at Arpachiyah (Mallowan and Rose 1935: 11–16) and Tepe Gawra (Tobler 1950). The landscape seems thus to be occupied by a number of small villages of more or less similar dimensions; a noticeable exception is the case of Tell al Hawa, which emerges as a likely major centre of the NJP area with a settlement covering an area of 15 to 18 hectares (Ball 1990; Ball *et al.* 1989: 31; Wilkinson and Tucker 1995: 40, 78–79).

Apart from the Tell al Hawa case, it has been observed that this pattern of small sites does not match with evidence from neighbouring regions, where major sites emerge during the Ubaid Period (Algaze *et al.* 2012: 18). If this holds in part true, a closer look at the parallel case studies suggests that only Tell Brak is possibly a site with an extensive area settled during the late 6th and early-mid 5th millennium BC — an assumption based more on the results of archaeological excavations than on survey investigations (Oates 1987; Ur *et al.* 2011: 4). Further evidence is required before we can make firm size assessments for Tell Leilan, Hamoukar/Khirbet al Fakhar (Ur 2010) and Hammam et Turkmam (Akkermans 1988: 181).

More reliable evidence has been retrieved in the Balikh Survey (Trentin 2010), where a two-tier site hierarchy has been identified, with Tell as-Sawwan and Tell Zeidan (Stein 2012: 129; Trentin 2010) as the largest Ubaid sites, with a likely settled area of about 10/12 hectares each. However, both sites are multi-mounded occupations and may therefore represent the above-mentioned cyclical or sequential occupations (see below), again hampering the real understanding of settlement's extension (Trentin 2010: 334).

The question concerning the existence of a widespread two-tier hierarchy of Ubaid sites in North Mesopotamia — with settlements of considerable dimensions controlling areas occupied by smaller sites/villages — is still open and the real occurrence of very large Ubaid settlements in Upper Mesopotamia seems to depend more on assumptions rather than on real and solid survey data. Concentration of population is likely to have occurred during the Ubaid Period, although it is difficult to identify large sites in the archaeological record. In many cases pre- and proto-historic levels are hidden — if not entirely 'transformed' through the re-deposition of earlier materials (Ball 1990: 14; Nieuwenhuyse 2000: 183) — by later phases of occupation. The only concrete evidence seems to be at present Tell al Hawa and, possibly, Tell Brak (Oates 1987). Furthermore, it should be stressed that one of the most important Ubaid sites in Northern Mesopotamia — Tepe Gawra — with clear traces of socioeconomic complexity such as the 'Temple' of Level XIII or the occurrence of artifacts made up of exotic materials (Tobler 1950) measures probably only 2 hectares.

The site distribution seems to be more even than before; in this case the KDE analysis provides particularly useful insights for recognising underlying pattern (Figure 3.4). Although a general clustering is still present the pattern is rather different, with the previous circular-like agglomerations of sites now replaced by a shallower and more linear distribution (Figure 3.5). Some site groupings are still present both in the NJS and TERP areas, though they seem to be less marked than those observed during the Halaf phase. In general, Northern Ubaid sites are distributed along major watercourses (Akkermans and Schwartz 2003: 159; Trentin 2010; Ur and Wilkinson 2008: 306–307) but the linear distributions discussed here do not follow any specific watercourses or topographic features.

Rather, the linear proximity of the sites located at a few kilometres from each other suggests concern with contact between sites. The linearity of site locations might thus reflect the occurrence of a more solid and probably wide-ranging network of interconnections. The most widely exploited surface evidence to identify routes/paths among sites are the so-called 'hollow ways' (Branting *et al.* 2013: 141–143; Ur 2010: 76–80), but these start to occur consistently in the 3rd millennium, when dynamics of urbanisation 'explode' in Upper Mesopotamia with the emergence of giant sites like Hamoukar, Tell Brak, Tell al Hawa, and, probably, Nineveh (Ur and Wilkinson 2008: fig. 6; Wilkinson *et al.* 2013; Stronach 1994).[3] The above-described pattern dates much earlier and is thus likely to be affected by other factors (e.g., natural resources); further, it seems to still be affected by the previous Halaf settlement pattern as the persistence of a few site clusters testifies. Nevertheless, the change is quite neat and, as will be discussed below, its nature (depending on economic or social factors or maybe both) might reflect a crucial stage in the processes of ancient human communities towards the emergence of urbanisation.

Social landscape as a reflection of social life?

The pattern emerging through the KDE analysis opens up a new insight into different types of settlement within Halaf communities. Much has been said about cyclical occupation during the Halaf Period, thanks in particular to work at Tell Sabi Abyad, where excavations have brought to light a sequence of occupation, abandonment, and re-occupation that demonstrates the continuous shifting of inhabited areas within a single site. This has been used in particular to argue against the existence of large Halaf settlements (Akkermans 2013a: 70), and to demonstrate the formation of multiple areas of settlement within a single site. Similar arguments have also been put forward for Yarim Tepe I–III and Fıstılı Höyük (Bernbeck 2013; Frangipane 2013: 92). The interpretation of these multi-mounded settlements has been the subject of recent studies, with some archaeologists arguing that Halaf communities were engaged in a highly mobile form of existence resulting in repeated but impermanent occupation at a range of different locations (Bernbeck and Nieuwenhuyse 2013: 31–32). The Burnt House of Sabi Abyad, though dated to the transition between the Late Neolithic and the Halaf Period, (Akkermans 2013b) is a likely example of this, with a multi-roomed building dedicated to communal storage of private goods, as the retrieval of several sealings (but no seals) in its rooms testifies (Akkermans and Duistermaat 1997; Duistermaat 2013). The latter would have been used to protect personal property during periods of absence derived from this adaptable subsistence strategy based on long/short term mobility (Duistermaat 2013: 319)

The site clustering visible in this study seems to mirror at a much higher scale that identified at micro level. The presence of groups of sites covering an area with a diameter of about 3.5 km and characterised by a varying number of sites might be seen as analogous to the multiple mounding of the larger sites but spread over a larger area. The NJS and TERP datasets, the most reliable sources of information, provide evidence that

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[3] Hollow ways may have formed as early as the late 4th millennium, since there is a broad correlation between their pattern and the position of some major Late Chalcolithic sites (Wilkinson and Tucker 1995: 47). However, unequivocal archaeological evidence in support of Late Chalcolithic hollow ways is still missing.

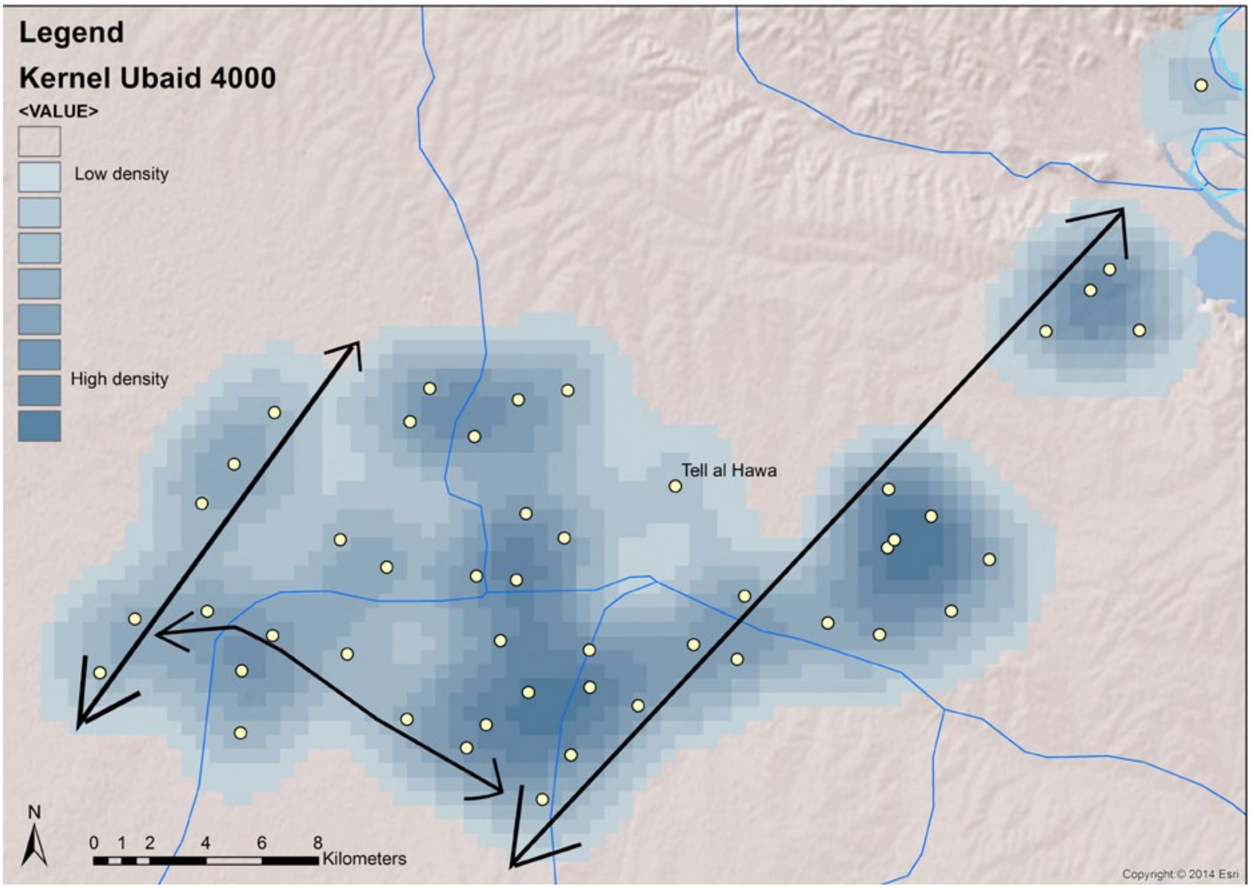

Figure 3.5. Detail of the KDE analysis of Ubaid sites in the NJS area, with the linear distributions indicated by the black arrows. Basemap by the author, using ESRI Topographic Data [Creative Commons]: World Shaded Relief and World Linear Water.

goes from a minimum of 4 to a maximum of 6 sites per cluster. Yet other case studies from the Eski Mosul Dam, though taken from salvage excavations and not of survey projects, reflect this pattern. A series of survey projects currently in progress in Iraqi Kurdistan — for the first available reports see those from the Erbil Plain Archaeological Survey/EPAS and the Land of Nineveh Archaeological Projects/LoNAP (Morandi Bonacossi and Iamoni 2015; Ur *et al.* 2013) — will provide significant evidence over large areas of the region that may help to further investigate this trend.

The multi-mounded site pattern has been also interpreted as evidence of some kind of internal cohesion based on kin related groups that may have occupied (and abandoned) each of these areas (Akkermans 2013a: 69; Frangipane 2013: 92). The Halaf is seen as a period characterised by great cultural homogeneity, thanks to a widespread occurrence of common elements in the material culture, among which the painted pottery is indeed the most famous, but definitely not the only one (Akkermans and Schwartz 2003: 150–151; Forest 2013; Nieuwenhuyse 2013; 2007b). Social activities like feasting have been advocated as major forces influencing the rise of a common ceramic tradition (Nieuwenhuyse 2008) for a largely egalitarian society (Frangipane 2002: 155–164), but with nascent elite groups likely based on age and kinships. These latter (kinship and lineages) may have been the basis of community segmentation but also at the same time of ancestral cultural unity, whose strength is reflected *inter alia* by wide sharing of decorated pots with similar patterns (Akkermans 2013a: 72; Akkermans and Schwartz 2003: 152–153).

This mechanism, identified at single Halaf sites, also seems to be evident in the KDE analysis. The site distribution, previously assumed to be randomly dispersed in the plains and regions of Upper Mesopotamia, shows a pattern that reflects the intra-site mechanisms of settlement formation. It is thus reasonable to think that the mobility and cohesion that resulted in settlements located within tens or hundreds of metres away from one another might have been responsible at a wider level for the creation of site aggregation. Halaf sites in the KDE analysis show a mean distance of less than 3 km, which is well below the hour-walk mark and correlates with 'home range'

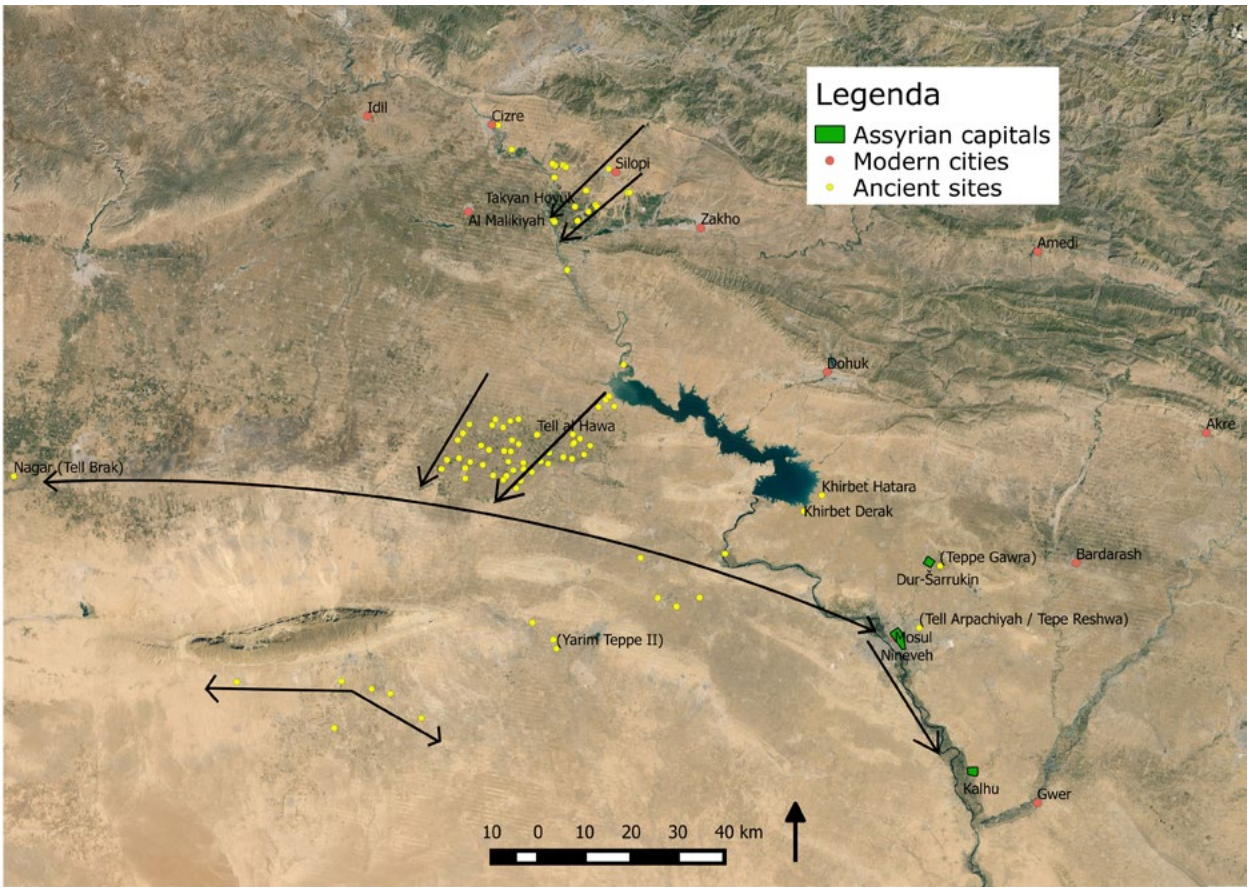

Figure 3.6. Upper Mesopotamia with the Ubaid sites and possible major routes across the region marked by black arrows. Basemap created by the author with QGis, using Google Earth imagery.

movement, and therefore with the occurrence of circumscribed networks of sites (see Niknami *et al.* 2009 for a similar case study from Urmia Lake).

Such short distances between the sites of each cluster suggest a strong integration between each community and reflect the social cohesion that, as seen above, is typical of Halaf societies. Assessing whether the formation of such groups of sites depends on single extended families/lineages whose growth has led to community segmentation and ultimately to the formation of new sites requires more evidence from key sites like Fıstıklı Höyük, where preliminary data point towards such interpretation (Pollock 2013). Leaving aside the origin of site clustering, the proximity of each group of sites (with one case of two groups almost melting into a single unity) is a further reflection at large scale of the strong level of social interrelation that must have characterised Halaf settlements.

The Ubaid Period (5300–4500 cal. BC: Stein 2012: 129, tab. 1), on the other hand, shows a substantial shift from the Halaf model. The latter shift looks to be of crucial importance, especially given the contemporary changes in socio dynamic complexities (Frangipane 2007; 2009: 135) that would form the basis for the phenomenon of urbanisation during the Late Chalcolithic (Carter and Philip 2010: 10–11; Stein 2010; 2012).

Among the many changes that occurred in the transition to Ubaid societies, of particular relevance is craft specialisation (Stein 2010: 28–29) in the production of common and prestige artifacts. At Tell Zeidan, for example, significant evidence for large-scale ceramic production has been excavated (Stein 2012: 130; see also Simpson 2007: 41 for wider references to ceramic kilns in Ubaid sites). In the same way, the working of exotic materials, e.g., lapis lazuli, turquoise, and carnelian, is extensively documented from the finds of Tepe Gawra, Level XIII (Tobler 1950: 192, 202). To these one must add obsidian, the relevance of which has been underestimated, but which occurred widely at the end of the Ubaid (Tobler 1950: 201) and in early LC contexts, such as at Khirbet al Fakhar (Al-Quntar *et al.* 2011). This suggests that it may have been of primary importance for ancient 5th millennium BC societies (Healey 2010). All these elements suggest the existence of a wider network of inter-regional exchange, which connected different regions throughout the late 6th and early 5th millennium BC (Stein 2010: 29; 2012: 130). Some areas, such as the Khabur Valley, may have already experienced, during the preceding Halaf Period, a similar phenomenon (possibly involving not only flint and obsidian but also pottery, cf. Davidson 1977: 332–333; Watson 1983: 240–241; Hijara 1997: 92–93), thus providing the basis for the later success of a crucial component of the Chalcolithic societies' economic strategies.

The KDE result fits well with this picture, as it demonstrates a clear change in the settlement pattern: the linear alignment of sites may, in fact, represent one of the longer multiple connection routes that crossed the study area in a northeast–southwest direction (but note possibly the other pattern south of the Jebel Sinjar that seems to be southeast–northwest oriented)[4] and suggests that connection/contacts and communication played a relevant role in the Northern Ubaid settlement.

The patchy coverage of the area does not allow us to go further in this interpretation, but it seems possible that the target of these hypothetical routes was the lower plain at the fringe of the Jebel Sinjar, likely for the exploitation of some kind of natural resources. In the absence of a survey project aimed at investigating in detail the northern region of the Jebel Sinjar, this interpretation remains a simple suggestion. An alternative interpretation would be that this alignment represents the earliest manifestation of the main route that crossed Upper Mesopotamia east–west, visible in later settlement patterns (see below). If this pattern is corroborated by future analysis it might suggest an earlier origin for the development of stable settlement networks, perhaps as early as the 5th millennium BC (for a summary of further evidence for this proposal during the Late Chalcolithic, see Iamoni 2014a). One strange characteristic of the settlement lay-out is the apparently marginal position of Tell al Hawa, but this might be a result of the blank area around the site, a likely consequence of later occupation and/or land-use that might have erased traces of earlier phases (Wilkinson and Tucker 1995: 41).

Another interesting aspect is the persistence of some groups of sites, which might further reflect the smooth passage — the HUT phenomenon — from a society strictly based on kinship/family ties, and thus in itself conservative (Frangipane 2009: 135), into a society oriented towards the acquisition of new materials probably necessary for the production of elite goods destined for emerging elites in communities showing the first traces of social hierarchy (Frangipane 2009: 136; 2007: 171–172; Stein 2012: 128–129). This must have happened at different levels, with different regions — or interaction spheres as Stein has recently proposed (2010: 37) — involved in different ways and possibly competing with each other for the acquisition of raw materials and the production of prestige items. The latter process might have achieved its apex at the turn between the Ubaid and the Late Chalcolithic, with a strong level of competition that might have caused the success of some sites, such as Tell Brak (McMahon 2013; Oates *et al.* 2007) and the decline of others such as Khirbet al Fakhar (Al-Quntar *et al.* 2011; Iamoni 2014a).

The Upper Tigris, as defined in this work, might be one of these spheres, along a major network (Figure 3.6) that crossed the entirety of Upper Mesopotamia and extended from the Jazira to Nineveh and then downriver to South Mesopotamia, a well-known communication route during the 3rd millennium BC (Lebeau 2000). Alternatively, the Upper Tigris region could split into two or more spheres. Again, it is to be expected that the current ongoing survey projects in Iraqi Kurdistan will provide substantial evidence to deepen our understanding of the modifications undergone by ancient societies in Northern Mesopotamia.

Be that as it may, the available evidence (much of it gathered by Tony Wilkinson and generously shared with colleagues) has demonstrated a clear relationship between intra-site social dynamics and settlement patterns, thus permitting us to propose the occurrence of a social landscape that is significantly linked to processes occurring at smaller scales. The study of the landscape has been of major interest, especially in historical archaeology, due to the clear impact complex states had on it. In particular, the later territorial empires (e.g., the Assyrian empire) have been widely investigated thanks to the control they exerted on the region and their attempts to culturally and physically modify it for economic reasons, such as a better exploitation of the natural resources for sustaining a growing population, as well as for self-celebration and self-justification of elite power (Morandi Bonacossi 2000; Wilkinson *et al.* 2005).

The above discussed Halaf and Northern Ubaid case studies do not include evidence of landscape change on this scale, yet they show that pre- and proto-historic communities also had a significant impact on the landscape (as another example, megalithic graves like tumuli as elements of the cultural landscape: Bradbury and Philip 2011: 176–178; Iamoni 2014b: 56; Porter 2002), and that the reading of this evidence can provide us with a new and alternative key to the interpretation of the socioeconomic dynamics that affected ancient societies.

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[4] A minor group of sites south of the Jebel Sinjar seems to be involved in a SE–NW axis of contact/communication, but the limited data (the sites are not the result of a systematic survey, rather of an explorative mission carried out during the 1940s) hampers a confirmation of this interpretation.

Acknowledgments

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Funerary Landscapes in the Land of Nineveh: Tracking Mobile Pastoralists in the Transtigridian Piedmont of Northern Iraq

Daniele Morandi Bonacossi

Few archaeologists can be credited with having developed and given such a decisive boost to a branch of their discipline as Tony did with regard to the archaeology of landscape in the ancient Near East. The groundbreaking research he conducted in Northern Mesopotamia and Southeastern Anatolia from the 1970s has greatly expanded the scope of landscape archaeology. Tony's research led to the development of new and more intensive field-survey strategies and models to explain the growth and contraction of the large Bronze Age urban centres in the dry-farming plains of Northern Mesopotamia, as well as the impact of artificial irrigation and manuring practices on subsistence in the 'Fragile Crescent'. At the same time, his field projects made it possible to define the dynamic nature of the relationships between sites and the surrounding landscape, highlighted by offsite archaeological features such as the dense network of linear hollow ways that radiate out from the region's main urban centres. As a result, landscape archaeology in the Near East today is indissolubly connected to Tony's field research and studies. I offer this article on the funerary landscape and pastoral mobility in the Eastern Upper Iraqi Tigris region, which is geographically so close to — but fascinatingly so different from — his 'North Jazira', as a tribute to Tony's memory.

Pastoral mobility in the alluvial plains, piedmont belts, and uplands of northern Mesopotamia: a problem of archaelogical field methods

Although seasonal pastoral sites have been the object of extensive and successful field research in other regions of the Near East (Barnard and Wendrich 2008; Bar-Yosef and Khazanov 1992; Cribb 1991; Hauser 2006; Khazanov 1994; Szuchman 2009; Wilkinson 2003: 151–183), little field research has yet been conducted on the problem of the visibility of pastoral groups in the alluvial areas of Northern Mesopotamia, such as the Upper Khabur and Tigris basins, or in the Northern Levant. Too strong is the attrition suffered by this vast region — characterised by sufficient rainfall for dry-farming, sedimentation, fertile soils, permanent cultivation, and a high degree of settlement continuity through time — to permit the survival of the scanty and ephemeral archaeological evidence left by non-sedentary communities. The presence of seasonal camps of pastoral groups has hitherto been inferred only from the presence of open, non-settled spaces between densely occupied zones — possibly used as pasturelands (Morandi Bonacossi 2007: 72; Wilkinson 2000a and 2003: 120–122), or very light scatters of surface finds (Lyonnet 1996: 371–372 and 2000; Ur 2010: 64–65). Field surveys in these regions, however, were never designed to document non-permanent occupation, since this would have required the implementation of intensive surface-material collection methods, and only in few commendable cases (in regions characterised by strong deposition) has the problem been approached by means of selective archaeological excavation (Alizadeh 2008: 94–99).

Recent and ancient patterns of vertical transhumance between lowland or valley-floor pasturelands and upland plains established by mobile pastoral communities in the highland landscapes of Northern Mesopotamia, however, have been the object of some ethno-archaeological and archaeological investigation, especially in Anatolian uplands (Cribb 1991: 196–207; Hammer 2014; 2018; Hütteroth 1959; Sevin 2004; Thevenin 2011; 2014; Ur and Hammer 2009; Wilkinson 2003: 184–209; Woods 1999; Yakar 2000). In spite of the considerable problems posed for archaeological survey by the rough terrain (ridges, steep valleys, overgrown slopes), which can make survey slow and difficult, more intensive pastoral-oriented research in the mountain landscapes of the Near East has been made possible particularly by the fact that in the highland regions archaeological landscapes have been less degraded, or concealed by natural and (especially) cultural transformation processes (Ur and Hammer 2009: 38; Wilkinson 2003: 184–186).

In contrast to the lack (in the alluvial plains of Northern Mesopotamia) or dearth (in its highlands) of specific problem-oriented field research, textual sources document the pervasive presence of semi-nomadic groups in the lowlands and uplands of Northern Mesopotamia at least from the late 3rd millennium BC onwards (Buccellati 2008; Charpin and Ziegler 2003; Dion 1997; Fleming 2004; Guarducci 2011: 13–28, 96–100; Kupper 1957; Lipiński 2000; Sader 1987). Their archaeological contextualisation, however, remains elusive and ambiguous, and disjunctures between historical and archaeological approaches continue to

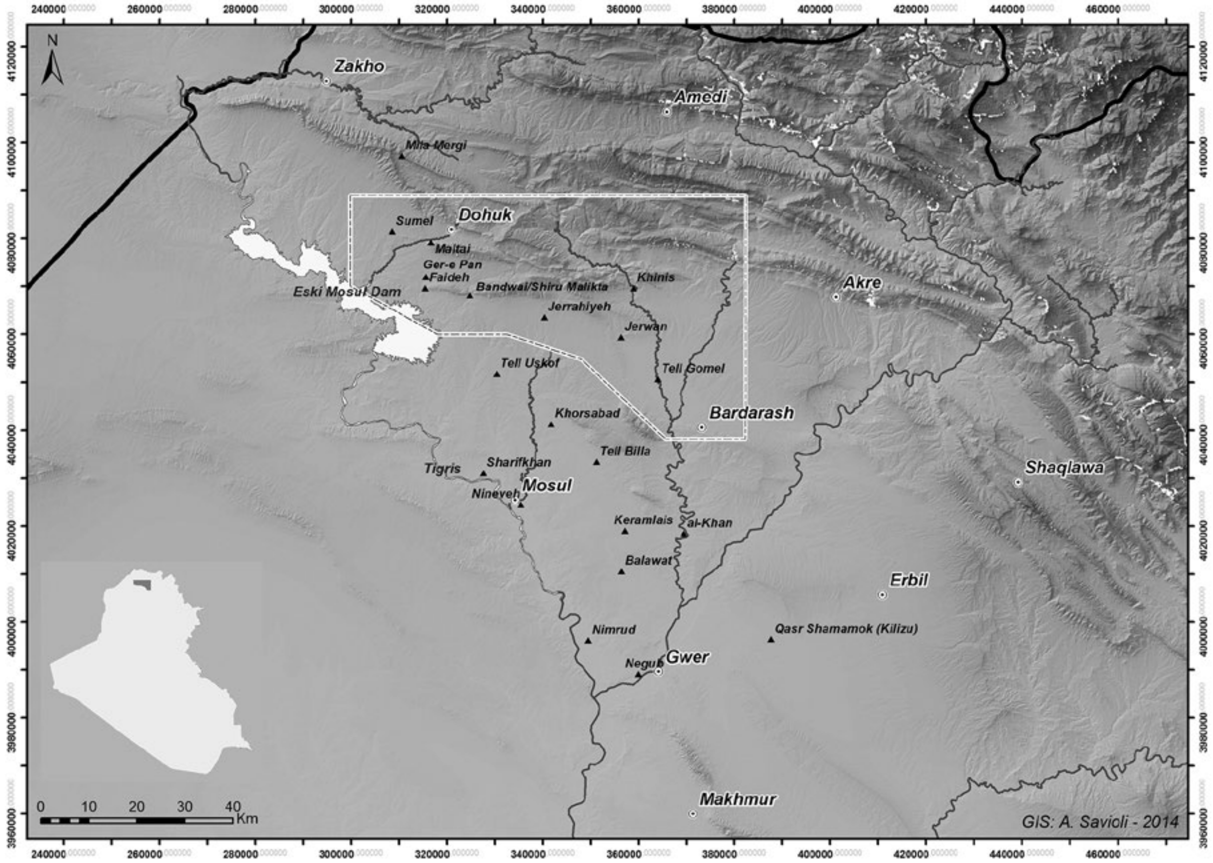

Figure 4.1. Location of the Land of Nineveh Archaeological Project (LoNAP) survey area in the northern region of Iraqi Kurdistan.

mark current studies on the Amorites, the Aramaeans, and the Bronze and Iron Age highland pastoralists of Eastern Anatolia and Iran (Burke 2014 and 2017; Guarducci 2011; Lönnqvist 2000; 2008; Lönnqvist *et al.* 2011; Matney 2010; Potts 2014: xii; Sagona and Zimansky 2009: 318–320; Schwartz 1989; Sevin 1999; 2004; Yakar 2000).

The survey launched in 2012 by Udine University's 'Land of Nineveh Archaeological Project' (LoNAP), in the plains, piedmont, and first Zagros foothills east of the Tigris in Northern Iraqi Kurdistan, has allowed for the first time the exploration in a systematic way, and using modern methods, of a region of Northern Mesopotamia never before investigated, which is located right at the junction between the northern alluvial plains of the 'Assyrian Triangle' and the foothills of the Zagros (Figure 4.1). Due to its geographic and ecologic setting at the intersection of potential transhumance routes linking lowland, or valley-floor, pasturelands and upland plains, the region represents a key study area for developing an archaeological approach to the analysis of pastoral landscapes and to investigate the symbiosis between mobile pastoralists and sedentary communities typical of dimorphic societies (Rowton 1973; 1974; 1976).[1]

The land of Nineveh archaeological project. Goals, landscapes and methods

LoNAP is an integrated landscape archaeology project, that aims to understand the formation and transformation of the cultural and natural landscapes of a strategic region of Northern Mesopotamia, that includes large parts of the governorates of Ninawa and Dohuk, from the Palaeolithic to the Islamic Period, and to enable its protection and management using innovative strategies (Morandi Bonacossi 2012–2013; 2016; Morandi Bonacossi and Iamoni 2015). The research is based on a regional archaeological surface

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[1] Travellers in the region in the early 20th century record the presence of the Heriki, 'a large tribe of Kurdish nomads who encamp in winter on the plain of Mosul and in summer on the loftier and cooler plateau of Urmi' (Wigram and Wigram 1922: 51). For a description of the Kurdish Missouri tribe in the region, see also Layard 1849: 147–172. For recent changes in the socioeconomic organisation of pastoral communities in Iraqi Kurdistan, and the social and political organisation of Kurdish tribes, see Dziegiel 1981 and Van Bruinessen 1992: 50–132.

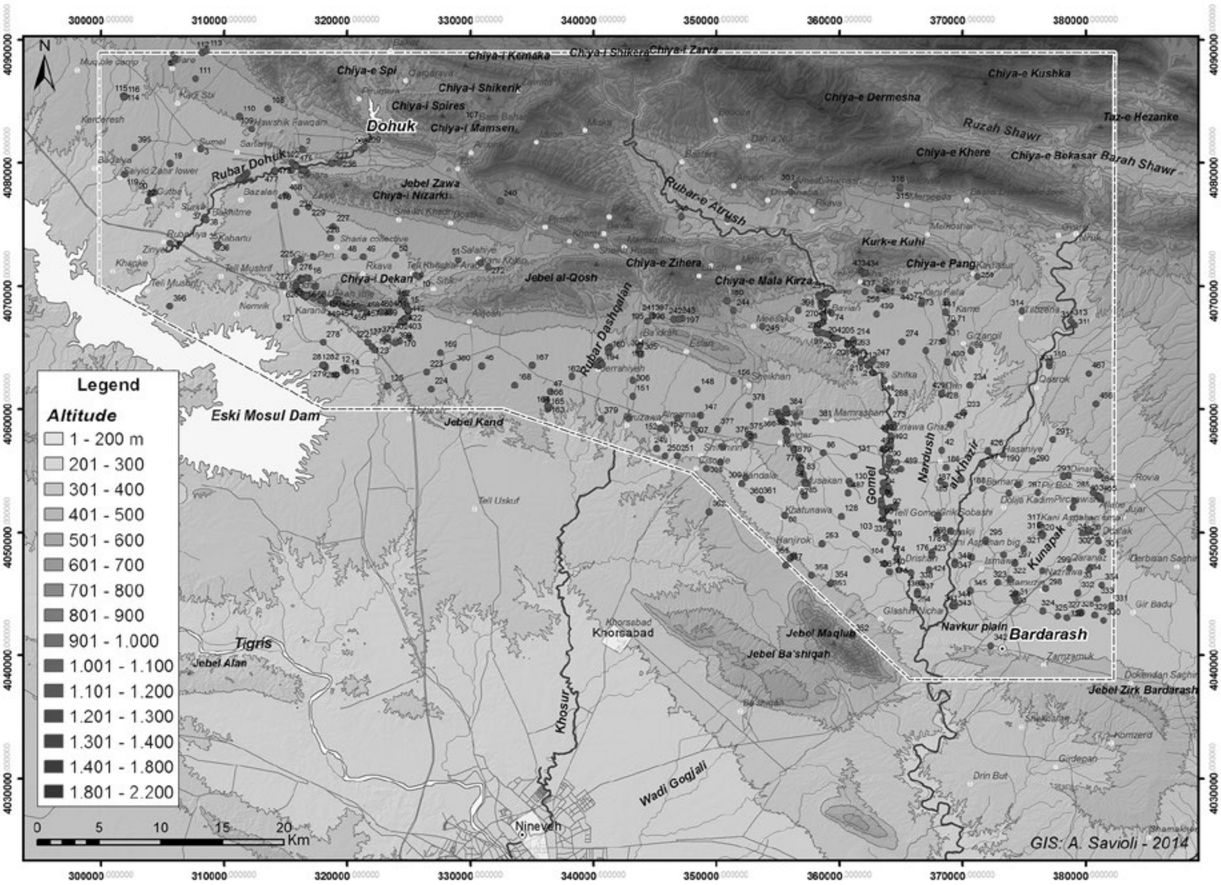

Figure 4.2. Preliminary distribution of archaeological sites discovered in the 2012 and 2013 survey campaigns.

survey in the area delimited by the plain of Dohuk and the Zagros foothills to the north, the lake formed by the Eski Mosul Dam to the west, and the Navkur plain that extends from Jebel Maqloub to the Rivers Gomel and Al-Khazir (a tributary of the Upper Zab) and the Bardarash region to the east (Figure 4.2). Its goals are to understand patterns of settlement, land use, and management, especially with regard to fundamental resources: water and agricultural soils. Field surveying is combined with the archaeological excavation of the site of Gir-e Gomel — a mid-sized site (see below) that, as the survey results show (Morandi Bonacossi *et. al.* 2018), was continually settled from the Late Chalcolithic to the Late Islamic Period — and a geo- and bio-archaeological reconstruction of the ancient natural landscape, and its evolution as a result of global climatic fluctuations and anthropogenic impact.

A significant portion of the approximately 3000 sq km explored by LoNAP (Figure 4.2) is occupied by the foothills of the Zagros Mountains (1230 sq km, 42% of the total area), a region of remarkable ecological and archaeological importance (especially for mobile pastoral groups) dotted with dozens of caves and rock-shelters, but only partially accessible due to the presence of numerous, still uncleared, minefields and widespread unexploded ordnance left by the conflicts of recent decades and characterised by limited archaeological visibility due to its rough terrain and lush vegetation. The gently undulating Transtigridian plains, which are crossed by several tributaries of the Tigris (Rubar Dohuk, Bandawai Stream, Rubar Dashqalan, and River Khosr) and the Upper Zab (Rivers Gomel and Al-Khazir), begin at the foot of the first Zagros foothills, along which numerous karst springs are aligned. Even though the western plains of the LoNAP area (Dohuk, Sumel, Faideh, Al-Qosh, Ba'adreh) are distinguished by shallower agricultural soils and are less well watered, they are suitable for dry-farming and grazing (Figure 4.3). Deeper agricultural soils characterise the Navkur Plain ('plain of mud' in Kurmanji), in the southeastern part of the study area, where most of the archaeological sites are concentrated along the courses of the Gomel and Al-Khazir rivers and their tributary wadis (Figure 4.2). The region benefits from fertile agricultural soils, mainly 'Brown Soils (Deep Phase)' and locally 'Reddish-Brown Soils (Deep Phase)' which, in the presence of sufficient rainfall, can produce rich crop yields (Buringh 1960: folding chart). Mean annual rainfall in the LoNAP region is

Figure 4.3. The western plains of the LoNAP survey area

from 450 to 600 mm per year, dropping to 300–450 mm in drought years (Buringh 1960; Guest 1966: figs 5–6; Wirth 1962: Abb. 9–10). Cereals can be cultivated using a dry-farming system (based on wheat cultivation and, to a much lesser extent, barley), which is also locally enhanced by irrigation, particularly in the water-rich plain of Navkur, where rice and various kinds of fruit and vegetables are also grown.

Archaeological visibility in the Transtigridian lowland region during summer and autumn, when LoNAP conducts its field season (late July to mid-October), is on average high, thanks to the intensity of modern pastoral activity. After harvesting, small herds from the local villages and larger herds trucked into the area from the Mosul plains to the south graze the fields, which at this time of the year are thus cleared of any remains of cereal crops and easily visible for surveying.

LoNAP's field-walking survey in the Transtigridian plains and piedmont region was preceded by the systematic examination of available cartographic sources[2] and the analysis and interpretation of satellite images, which made it possible to make a preliminary identification of potential archaeological sites and ancient infrastructures (e.g., tracks, canals and off-take channels). Particularly useful in this analysis has been declassified CORONA satellite imagery[3], which makes available to archaeological research photographs of the region dating to a period at which urban growth and mechanised intensive agriculture had not yet radically transformed and partly obscured ancient cultural landscapes (Altaweel 2008; Menze *et al.* 2007; Menze and Ur 2012; Mühl 2012; 2013; Ur 2003; 2005; 2010; 2013a; 2013b).

In contrast to the intensive field-walking methodologies typical of current Mediterranean surveys (for a review, see Mattingly 2000), the strategies of extensive (or low-intensity) survey used over the past century to cover the huge expanses of the still unexplored Mesopotamian plains, were justified by the characteristically high visibility of archaeological landscapes in this region, dominated by highly obtrusive mounded sites (Ur 2010; Wilkinson 2000b). However, Mesopotamian surveys often entailed substantial methodological shortcomings due to the absence, or inadequacy, of their off-site component. These limitations have reduced the visibility of significant portions of Mesopotamian archaeological landscapes — especially with regard to small habitation sites, or those settled at low intensity,

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[2] In particular the *Atlas of Archaeological Sites in Iraq*, Directorate General of Antiquities, Baghdad 1970 and its supplement *Archaeological Sites in Iraq*, Directorate General of Antiquities, Baghdad 1976.

[3] Especially Missions 1039 (February 28, 1967), 1102 (December 11, 1967), 1104 (August 16, 1967) and 1107 (August 3, 1969).

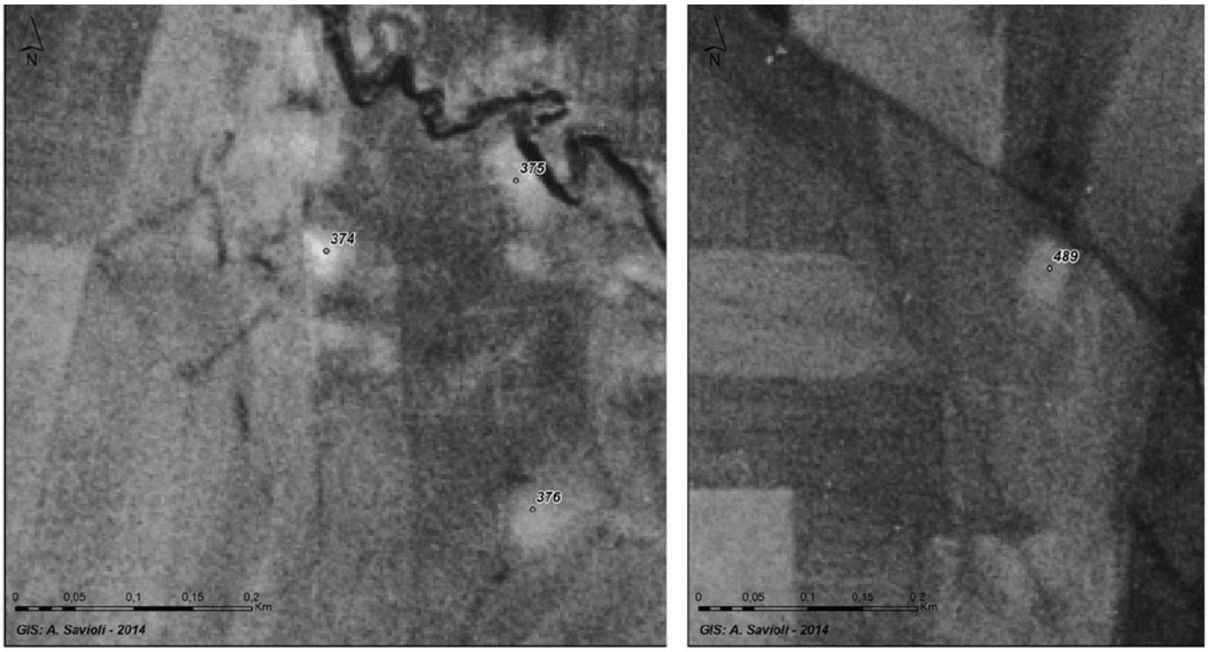

Figure 4.4. Small, low-mounded and flat sites detected on CORONA images (Mission 1039, February 28, 1967) thanks to their anthrosol signatures (site 374: h. 1 m, area 0.20 ha; site 375: h. 1 m, area 0.31 ha; site 376: h. 1 m, area 0.37 ha; site 489: h. less than 1 m, area 0.22 ha).

early occupation levels masked by later accumulations, or buried beneath alluvium and off-site archaeological features related to production or other activities (canals, wells, mills, quarries, kilns, outbuildings, animal enclosures, cemeteries, and ancient routes). This data loss, or underestimation, has often led to skewed — if not indeed biased — reconstructions of a territory's occupation pattern and settlement hierarchies. A case in point is the rendering silent a crucial segment of the population (and subsistence strategies) of Mesopotamia, such as mobile pastoral groups, or underestimation of the role played by small rural sites, hamlets, or isolated farmsteads in the overall functioning of a settlement system.

To limit these methodological shortcomings and at the same time cope efficiently with the vast size of the LoNAP study area, we have developed a mixed survey strategy articulated in three different levels; based on motor vehicle survey, combined with pedestrian field-walking with different degrees of intensity.

To begin with, the entire LoNAP lowland region was investigated extensively through a vehicular survey to obtain ground control of the potential archaeological sites detected by means of systematic and intensive satellite imagery analysis (Savioli in preparation). During this first working phase in the field, which has occupied a crew of six surveyors for two seasons, off-site survey through transect walking, aimed at detecting small low-mounded sites and non-mounded clusters of surface material, has been made largely superfluous by the high degree of precision now obtainable in the identification of archaeological sites by means of anthrosol detection on satellite imagery (Menze and Ur 2012). Many low-mounded sites (even small tells of up to 0.2 ha and only 1 m in height), and several flat sites (elevation 0–1 m), were identified on CORONA images thanks to the signature provided by anthrosols; these were subsequently investigated on the ground (Figure 4.4).

In the second stage of fieldwork, a more intensive survey strategy has been implemented in the off-site areas, with the aim of establishing the presence of sites not recognised through remotely-sensed image analysis or extensive survey, registering field scatters, and exploring ancient land-use (Ur 2010; Wilkinson 1989; 1994; Wilkinson and Tucker 1995; Wilkinson 2003) and communication patterns (Ur 2003; 2010; Wilkinson 1993; 2003). With this aim, field-walking has been conducted along transects (selected according to surface visibility and ground conditions) radiating out from the largest sites detected in the Dohuk, Ba'adreh, and Navkur plains. Ceramic diagnostics and artifacts has been collected and sherds counted in order to assess variation in field scatter density and thus investigate the possible use in the Transtigridian plains of Northern Iraqi Kurdistan of the ancient manuring practices that permitted agricultural intensification; already reconstructed by Wilkinson in the adjacent Iraqi Jezirah (Wilkinson 1982; Wilkinson and Tucker 1995: 19–23) and Ur in the Hamoukar region of northeastern Syria (Ur 2010: 65–76).

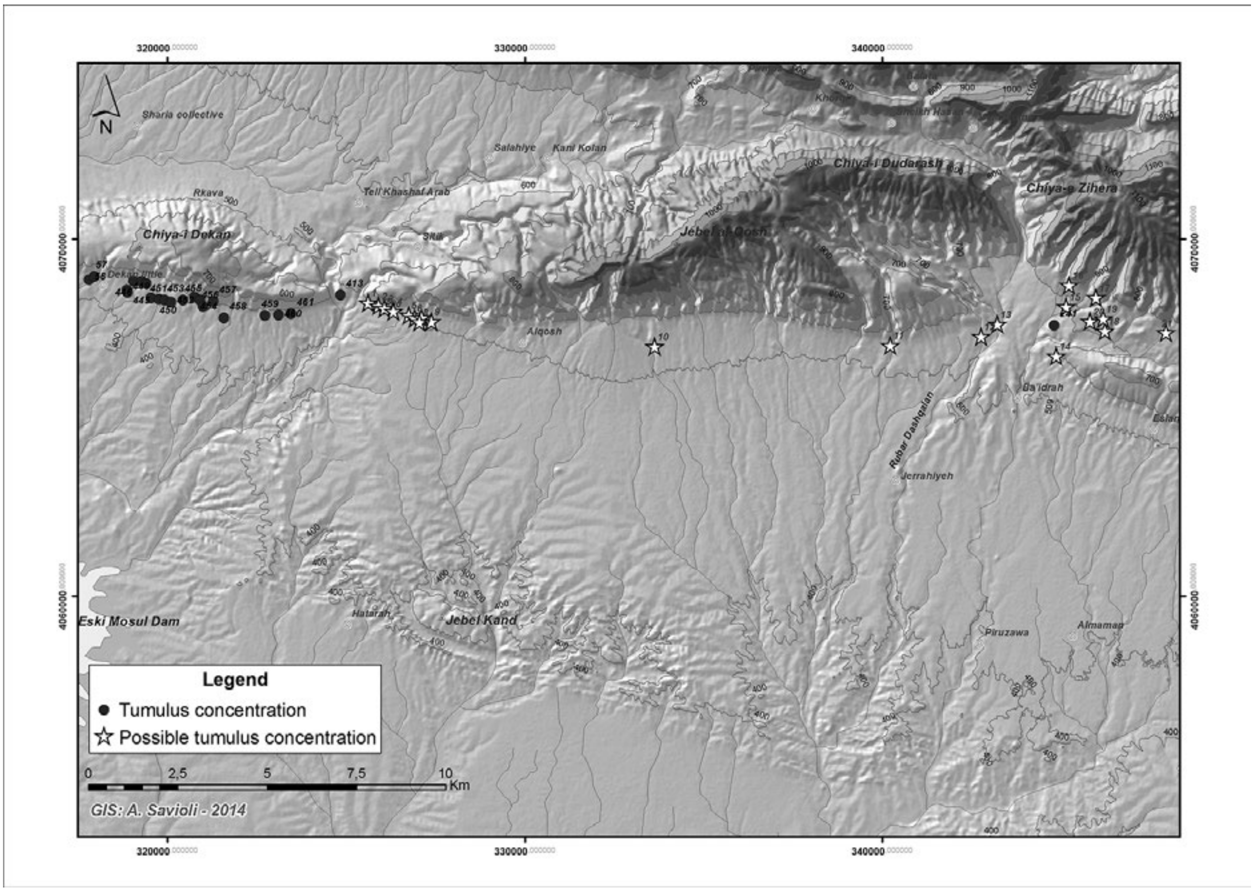

Figure 4.5. Preliminary distribution of surveyed and possible (recorded from satellite imagery but not yet ground-truthed) cairn clusters and fields.

Finally, on a third level of intensity based on off-site transect lines laid out across the area to be surveyed, a region of 100 sq km centred on Gir-e Gomel, in the lower valley of the river of the same name, has been investigated (Simi 2019). With its notable size (an original surface area of approximately 35 ha),[4] continuous occupation for around seven millennia (also suggested by the height of the tell, which rises more than 40 m from the bed of the Gomel), and its strategic position on the left bank of the river (almost at the centre of the fertile Navkur plain), Gir-e Gomel is the most important site in the area.[5] This programme has involved a systematic surface collection in the area of the site aimed at identifying its dimensions and the limits of urban expansion in the different phases of its history. This has been paralleled by an intensive survey of the surrounding micro-region in the heart of the Navkur Plain based on transects radiating out from Gir-e Gomel and placed between the Rivers Gomel, Nardush, and Al-Khazir. No small-scale intensive survey has ever been conducted in the Navkur Plain, although its importance is clear from the large numbers of archaeological sites identified in this region by our extensive survey (Figure 4.2).

The integration of these three research phases has allowed us not only to better define settlement landscapes (especially of the earlier periods, which might be deeply buried under later deposits) and productive landscapes, but also to identify features belonging to the often-invisible pastoral horizon.

Landscapes of burial in the land behind Nineveh. The cairn fields in the Faideh, Al-Qosh, and Ba'adreh Piedmont belt

So far, the extensive survey conducted in the LoNAP lowland and piedmont region has detected a number of sites that may be associated with mobile pastoralism, such as medieval cave dwellings reused as animal shelters

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[4] It is the most extensive site in the region east of the Tigris and, at present, covers a surface area of 28 ha. However, the River Gomel has eroded away the western portion of the tell and the northern and southern lower city, which must originally have been much larger, probably reaching an overall area of about 35 ha (approximately one third of the site has been removed by river erosion; Morandi Bonacossi *et al.* 2018, 69-74).

[5] Gomel has been tentatively identified by Fales and Del Fabbro (2014) and Reade and Anderson (2013: 75–76) as the ancient Assyrian city of Gammagara, mentioned in the Inscription B of Sennacherib at Jerwan (Jacobsen and Lloyd 1935: 20–21, 32).

Figure 4.6. View of the cairns of site 451 from the south. Note the location of the cairns on the detritus cone deposits of the Chiya-i Dekan slopes.

Figure 4.7. View of the tumuli of cairn field 241 from the south. Note the Rubar Dashqalan Gorge in the background (centre).

Table 4.1. Surveyed cairn clusters and fields.

Site number/ Name	Description	Associated material	Altitude in m a.s.l.
56	Cluster of 5 cairns	no artifacts	597
57 Dekan Sagheer	Two isolated cairns	1 Neo-Assyrian sherd, 3 Islamic, 5 undetermined	447
241/397	Cairn field (17 cairns). The largest cairn has a diameter of circa 7 m and a height of 4 m. Some of the cairns have probably been looted in antiquity	26 Middle Bronze Age sherds, 11 undet.	605
413	Large isolated tumulus, diameter circa 10 m (probably looted)	no artifacts	495
444	Three isolated cairns (diameter 3–4 m) associated with rectangular graves.	no artifacts	448
445	Two isolated cairns (diameter 2 m)	no artifacts	449
446	Large cairn field with about 40 tumuli (diameter 1–3 m)	1 Neo-Assyrian sherd, 1 undet.	464
447	Three tumuli (diameter 4 m)	4 Islamic sherds	460
448	Cairn field of about 15 tumuli (diameter 4–5 m)	no artifacts	466
449	Three tumuli	no artifacts	460
450	Large cairn field (about 30) scattered over a 6–8 ha area. Three large cairns are sub-rectangular (15 x 6 m) and contain circular structures	no artifacts	451
451	Cairn field with about 20 tumuli (diameter 3–4 m)	no artifacts	480
452	Cairn field with about 20 tumuli (diameter 3–4 m)	no artifacts	468
453	Cairn field with about 20 tumuli (diameter 3–4 m)	no artifacts	491
454	Cairn field with about 12 tumuli (diameter 3–4 m)	no artifacts	500
455	Cairn field with about 20 tumuli (diameter 3–4 m)	no artifacts	475
456	Cairn field with about 20 tumuli (diameter 3–4 m)	no artifacts	489
457	Cairn field with about 10 tumuli (diameter 3–4 m)	no artifacts	495
458 Dekan Kabir	Cairn field with about 15 tumuli (diameter 3–4 m). Most of the cairns have been looted in recent years by the villagers of Dekan Kabir	2 Islamic sherds, 1 undet.	475
459	Cairn field with about 10 tumuli (diameter 3–4 m)	no artifacts	498
460	Three isolated cairns	no artifacts	489
461	Cairn field with a dozen small tumuli	no artifacts	488

by later pastoral nomadic groups. However, though our research is still at an early stage in this respect, cairns (or tumuli) represent the most striking and widespread feature. These occur sometimes in seeming isolation, but are found far more frequently in discrete clusters and also as more extensive spreads — cairn fields and have hitherto been detected only in the upper regions of the Transtigridian foothill plains (450/500–600 m altitude belt, Figure 4.5), in very localised areas at the interface between the cultivated zones and those that are not suitable for agriculture because the soils are thin or eroded. Their setting, confined to a very specific ecotone located at the transition between the alluvial plain and the lowest portions of the first Zagros piedmont belt — debris-flow fan deposits — makes it clear that these structures cannot be explained as the result of the clearance of stones from agricultural fields (i.e. to remove impediments to the plough), or as boundary markers, but are to be considered as proper cairns.[6] At the foot of the east–west oriented Chiya-i Dekan hills, the Jebel Al-Qosh, and Chiya-e Zihera mountain ranges, dense concentrations of cairns have been detected. Apart from cairn field 241, the two site 445 tumuli and three site 449 cairns, which were built on top of small hills (see below), all cairn clusters and fields were selectively positioned on debris-flow fan deposits at the foot of these ranges and were therefore established in locations that were prominent, easily visible from afar, and protected from rain-wash erosion, which was channeled between the already stabilised debris-flow fan deposits. The tumuli, which are arrayed in parallel lines along the Zagros foothill slopes (Figure 4.6), are normally circular, built of unworked stones and of variable dimensions, ranging from small cairns averaging 3–4 m in diameter and 0.5–1 m in height (the majority) to more monumental tumuli measuring 7–8 m across and 3–4 m high. Most of the cairns, however, are of modest size and aspect — often being no more than a heap of collapsed stones — and are heavily eroded and poorly preserved. Variable amounts of lichen coat the cairn stones, but it is not currently possible to tell what lichen growth and the eroded state of the tumuli mean, in terms of time elapsed since their construction.

Table 4.1 presents a short description of the isolated tumuli, cairn clusters and fields, and the dating of the few archaeological finds recovered from their surfaces. To date, about 280 cairns have been recorded and checked in the field during survey. None has yet been excavated archaeologically, so some caution is required in their interpretation; LoNAP is planning to excavate some of the tumuli in the future. I will describe below some of the most significant cairn fields discovered and ground-truthed. One of the most remarkable cairn concentrations is site 241/397, a field of 17 cairns built on the top of a small hillock overlooking the Sheikhan-Ba'adreh road, less than two kilometres southeast of the Ba'adreh checkpoint (Figure 4.5). Particularly prominent among these circular tumuli built with rough stones and soil is a cairn about 7 m in diameter and 4 m high (Figure 4.7).

Smaller cairns composed of the same materials surround this tumulus. The main cairn and other tumuli might have been looted in antiquity, as the presence of partially-infilled depressions on their summits or sides may suggest. The surface of the cairn field was scattered with Middle Bronze Age ceramic material (Table 4.1). Of course, surface artifact assemblages from these cairn fields might not be associated with the tumuli themselves and therefore such material cannot necessarily be used to date them reliably (this is particularly evident when only a few scattered sherds belonging to different periods are found). The pottery surface collection from the site was thus labeled separately (no. 397) from the cairn field, to prevent the assumption that the cairns date to the Middle Bronze Age. However, the presence on the cairn field surface of a large quantity of diagnostic pottery, all of which belongs to a single period, suggests that the pottery comes from the use of the funerary area and the looting of the cairns. Therefore these structures may well date to the first-half of the 2nd millennium BC, although only excavation will provide us with a secure chronological attribution.

Sites 413 and 445 (Figures 4.8, 4.9) are also isolated tumuli (one and two respectively). The first overlooks the Bandawai Gorge at the point at which the watercourse flows through a narrow passage between the Chiya-i Dekan hills and the Jebel Al-Qosh range, the second stands on a small hillock in the Chiya-i Dekan piedmont.

Particularly interesting are sites 450–454, which are large cairn fields located in the Chiya-i Dekan piedmont belt. These consist of a substantial number of tumuli, ranging from a dozen to about 30 (Figure 4.10), arrayed in a north–south alignment alongside the lowest extents of debris-flow fan deposits (Figure 4.11). The largest cairn field is site 450, which covers an area of 6–8 ha and includes about 30 tumuli of different sizes. Three are sub-rectangular, measuring approximately 15 x 6 m, and contain internal structures or chambers (Figure 4.12).

Site 458 is a minor cairn field of about 15 small structures located on the western fringe of the village of Dekan Kabir. Local villagers have systematically looted most of the cairns in recent years (Figure 4.13). The evidence indicates that an impressive, uninterrupted

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[6] Moreover, LoNAP cairn clusters and fields are also visible in the CORONA imagery of the region that was used to map potential cairns. These photographs were taken in the late 1960s and predate modern agricultural intensification in the region and presumably any large-scale clearance activity for agricultural purposes.

Figure 4.8. View of tumulus 413 from the south.

Figure 4.9. View of the tumuli of site 445 from the northeast.

Figure 4.10. View of a cairn of site 454 from the east.

Figure 4.11. View of the tumuli of site 453 from the southeast with Chiya-i Dekan slopes and detritus cone deposits.

Figure 4.12. (Right) View of a cairn of site 450 from the southeast. Note the internal structure or chamber.

chain of cairn fields stretched for a distance of almost 6 kilometres along the debris-flow fan deposits located at the foot of the Chiya-i Dekan hills, at the interface between the agricultural and non-cultivated zones (Figure 4.4). Most of the largest and densest cairn fields were concentrated between the modern villages of Dekan Sagheer and Dekan Kabir (site 456). Between the latter and the Bandawai Valley to the east, the number of cairn fields — and their size — diminished (Figure 4.5, Table 4.1).

Immediately to the east of the point where the Bandawai stream emerged onto the plain from a narrow ravine,[7] analysis of CORONA photographs has

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[7] Marked by the presence of the Assyrian rock relief of Shiru Maliktha

Figure 4.13. View of a recently looted cairn of site 458.

revealed the existence of a new sequence of nine cairn clusters and fields of the same type as those described above, densely arrayed along a two kilometre front (Figure 4.5, numbers 1–9). These tumuli have not yet been surveyed in the field and, in the absence of ground control, can at present be regarded only as possible cairn concentrations, each comprising a dozen or so tumuli. A couple of other as yet unsurveyed cairn fields are probably present at the foot of the Jebel Al-Qosh to the east of the modern town of this name (Figure 4.5, numbers 10–11), and a further possible concentration of tumulus clusters and fields has been detected in a topographic setting similar to that of the Bandawai cairn fields mentioned above. Cairn fields 12–21 are concentrated to the north of the Ba'adreh village, left and right of the gorge outlet between the Chiya-i Dudarash and Chiya-i Zihera ranges, where the upper course of the Rubar Dashqalan (a tributary of the River Khosr) flows into the plain. As in the Chiya-i Dekan and Jebel Al-Qosh piedmont, all potential cairn groups are situated on the lower segments of debris fan deposits. Most cairn fields in this area are located in a narrow side-valley delimited by the Chiya-i Zihera and Jebel Sheikhan ranges on the Chiya-i Zihera detritus cone deposits opposite the cairns on hilltop site 241: two other groups of cairns (12 and 13) overlook the Rubar Dashqalan. If these possible cairn fields detected in CORONA images are verified by future fieldwork, the selective location of cairn clusters and fields in the transition belt between the Transtigridian plains and the first Zagros foothills will be confirmed as an even more extensive phenomenon. Future survey seasons and the excavation of a selected sample of cairns will certainly enlarge our knowledge of the tumulus horizon of the Transtigridian piedmont belt of Northern Mesopotamia — its diffusion, function, and chronology.

Cairn clusters and fields, similar to those detected in our study region, have however already been reported from numerous areas of the Near East, ranging from the Transcaucasian region (Edens 1995; Sagona 2004) and Iraq (Kepinski 2006) to Syria and Lebanon (Bradbury and Philip 2011; du Mesnil du Buisson 1948; Fujii 2014; Fujii and Adachi 2010; Iamoni 2014; Lönnqvist 2010; Morandi Bonacossi and Iamoni 2012; Nishiaki 2014; Steimer-Herbet 2000; 2004; Steimer-Herbet and Braemer 1999), the Southern Levant (Haiman 1992; Prag 1995; Rosen 2009; Rowan, Rollefson, and Kersel 2011; Stekelis 1935; Zohar 1992), and the Arabian Peninsula (During Caspers 1972; Højlund 2007; Laursen 2008; Lowe 1986; Steimer-Herbet 2004). In all these regions cairns have usually been interpreted as evidence for the presence of mobile pastoralist groups, and survey and excavation clearly attest their use as a burial form over a lengthy period, from the 6th to 2nd millennium BC with scattered later persistence.[8] This impressive and extremely widespread evidence strongly suggests that the few isolated cairns and the numerous cairn fields observed by LoNAP in the Transtigridian piedmont belt of Northern Iraqi Kurdistan represent cemeteries of the

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associated with a water tunnel fed by the Bandawai watercourse (Morandi Bonacossi and Iamoni 2015: 26–27; Reade 2002).

[8] The use of tumuli for burials, for instance, has been documented in the northern Jordan Basalt Desert of the Harrat ash-Sham also during the period circa 1st century BC to 4th century AD (Harding 1953; Kennedy 2012) and even in the 18th–19th centuries AD in the Jordan Valley (Sartre-Fauriat 2001: 174–177).

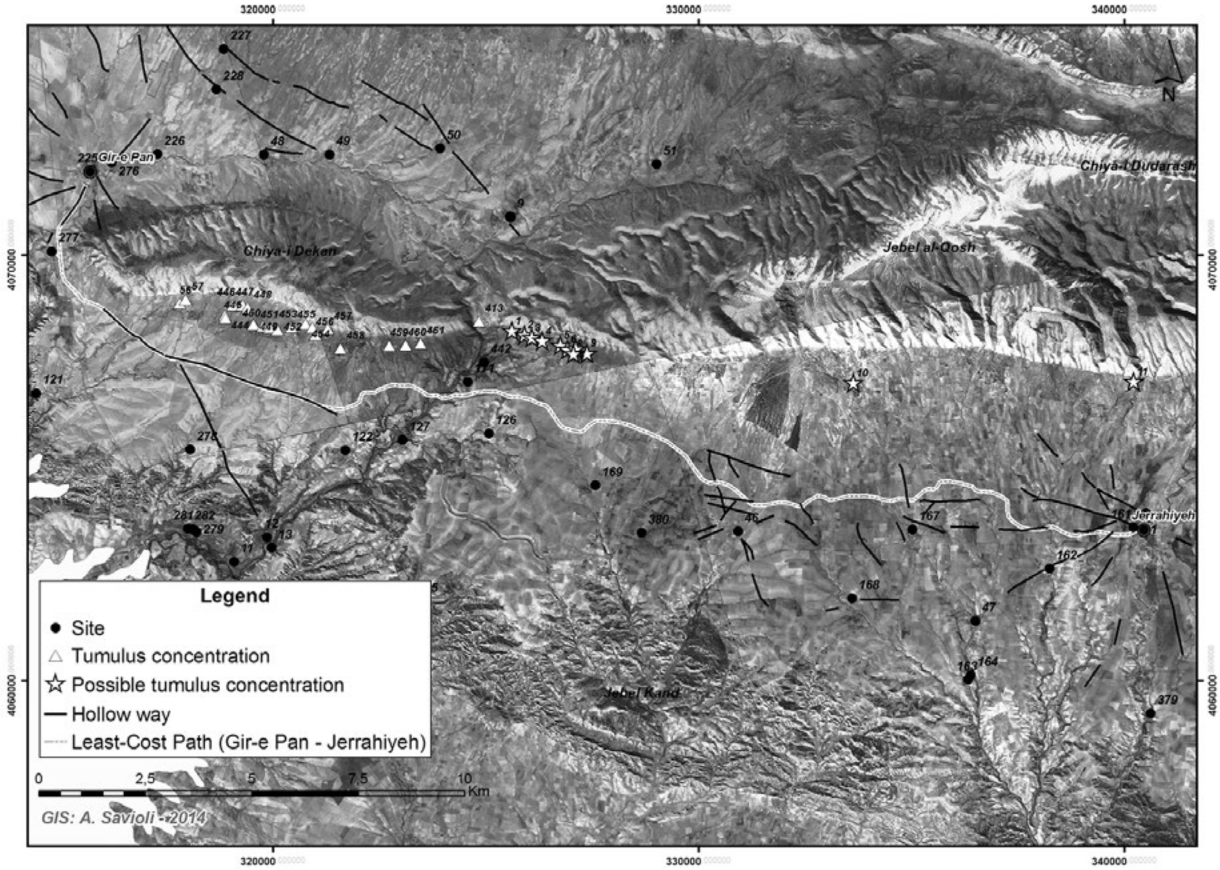

Figure 4.14. CORONA image of the region between Jerahiyah and Gir-e-pan (Mission 1039, February 28, 1967) showing cairn fields, archaeological sites, hollow ways, and the least-cost path.

local mobile pastoralist component of the population. Although some caution is still necessary and only the future archaeological excavation of selected cairns will allow the validation of this interpretation, the association of this extended burial landscape with non-sedentary pastoralist groups is further strengthened by the fact that none of the tumuli and cairn fields so far detected are associated with nearby settlements.

Discussion and conclusions

In the first two field seasons, the survey conducted by LoNAP has identified on the ground 493 archaeological sites, 281 of which have yielded surface pottery and/or lithic assemblages and can be classified as habitation sites.[9] Of these 493 sites, the pastoral cemeteries described above amount to 43, nearly 9% of the total and no less than 20% of the non-habitation sites. The funerary landscape emerging in the Transtigridian piedmont belt thus accounts for a significant part of the ancient cultural landscape of the region.

Archaeological research has shown that cairns are not only associated with burial, but may also have had significance as pivotal commemorative places for the re-negotiation of identity and re-formulation of social relations through acts such as feasting and offering practices (Bradbury and Philip 2011: 176; Charpin 2010; Chesson 2001: 110). Tumuli may be accompanied by paved areas or linked by walls that connect cairn groups and/or enclose them (Bradbury and Philip 2011: 175–176; Rosen 2009: 61). Cairns are also often associated with shrines (Rosen 2009: 61) and may have functioned as sacred places, i.e., as sites of ancestor worship by tribal communities (Nishiaki 2014: 117), and as landscape reference points, marking transhumance itineraries and acting as tribal landmarks (Charpin 2010: 244–245; Kepinski 2006: 107–108; 110: Morandi Bonacossi and Iamoni 2012: 52–54; Steimer-Herbet 2004: 95–97).

What is remarkable about the distribution of the cairn fields in our survey region is that they are an obtrusive,

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[9] The 212 sites not associated with archaeological material include many different non-settlement types, such as aqueducts, canals and off-take channels, weirs, sluices, stone water mills, quarries, and other productive installations, rock-reliefs, rock-graves, cairns, karst springs etc.

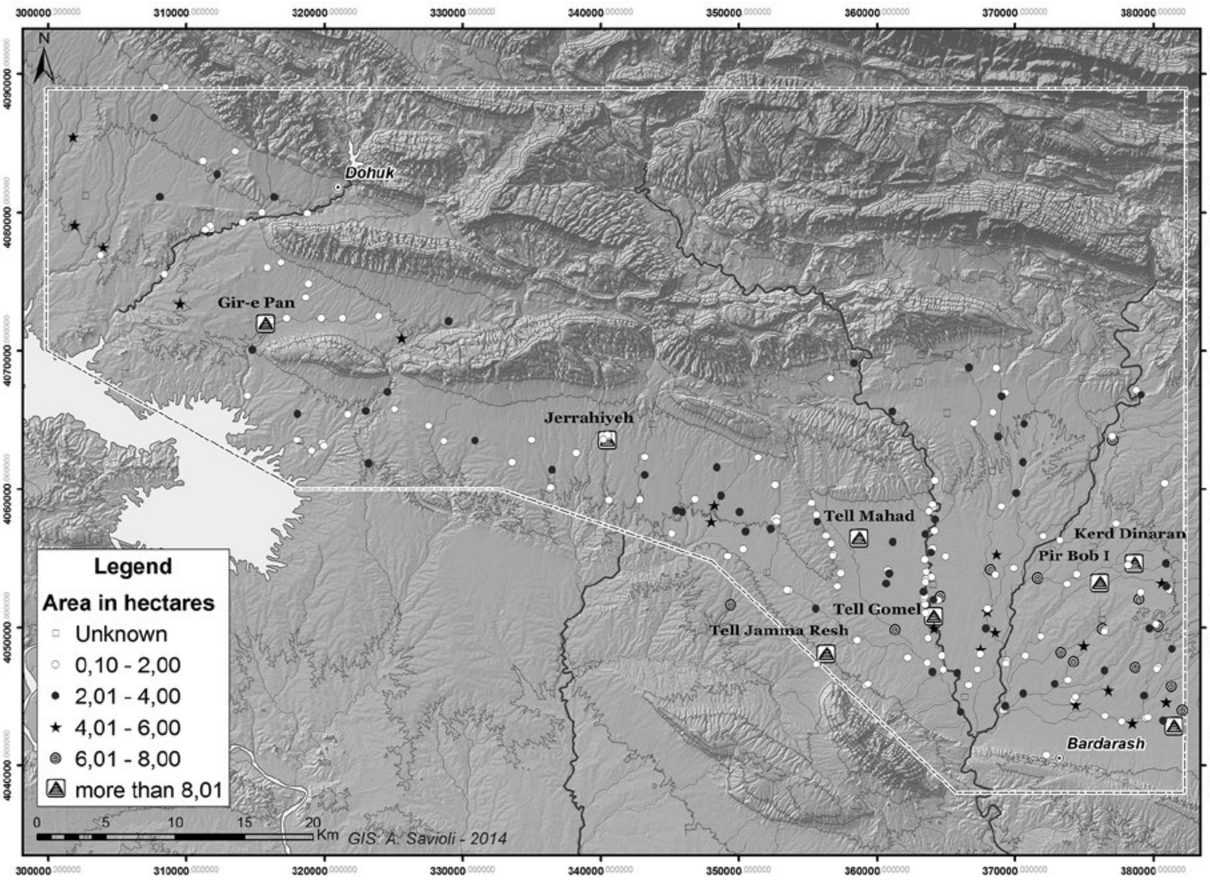

Figure 4.15. Preliminary assessment of settlement size classes.

but very localised phenomenon since — with the exception only of the hilltop cairn clusters 445, 449, and cairn field 241 — they are all located on stable detritus cone deposits at the foot of the first Zagros ranges. Furthermore, within this piedmont belt, they are concentrated in particular at the outlets of narrow river valleys (such as those of the Bandawai watercourse and Rubar Dashqalan) that — in antiquity as nowadays — were important natural routeways linking the intra-montane plain of Dohuk and the small Gir-e-pan/Sharia flatland to the open plains of the Nineveh hinterland and Navkur (Figures 4.2 and 4.5). Future fieldwork will allow us to ascertain whether additional cairn fields and clusters are to be found in other comparable physiographic locations in the piedmont belt, such as, for example, at the entrance to the upper Rubar Dashqalan Valley or the outlet of the Atrush Valley.[10] At present, the rough terrain characteristic of these areas does not allow for the unambiguous interpretation of satellite imagery.

The spatial distribution of burial cairns in the LoNAP region clearly indicates that these funerary monuments were deliberately concentrated in the Transtigridian piedmont belt at the margin between cultivated and non-cultivated zones — and that this ecotone therefore had a specialised funerary use for early local non-sedentary groups. The concentration of these pastoral cemeteries at the valley outlets, along routes possibly used by transhumant groups connecting lowland or valley-floor pasturelands with the upland plains of the Zagros foothills, may indicate that the non-sedentary communities used their megalithic graveyards to mark crucial stretches of their itineraries, in particular their junction with the wider alluvial plain where the winter pasture lands were located.

The programme of hollow way mapping conducted by LoNAP, with the aim of recording these linear features in the Transtigridian plains of Northern Iraqi Kurdistan in a GIS framework and reconstructing ancient landscapes of movement (Ur 2010: 76–87, 129–146; Wilkinson 1993; Wilkinson and Tucker 1995: 24–28), has evidenced the existence of a well-preserved east–west oriented hollow way starting at the site of Jerahiyah

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[10] The upper course of the River Gomel, from its source in the Chiya-i Shikerik mountains northeast of Dohuk to the outlet of the Khinis Gorge, is called Atrush.

(Figure 4.14).[11] The results of our survey indicate that the site has been continuously settled at least from the Late Chalcolithic onwards. However, it seems to have developed to a size that can be considered significant for the region only between the Ninevite 5 and Neo-Assyrian Periods, when it grew to an area of 8.5 ha (Figure 4.15). In comparison with the adjacent Iraqi Jazira and Upper Khabur basin of northeastern Syria (Wilkinson and Tucker 1995; Ur 2010), in our region the detection in the field of inter-site pathways is made difficult by the intensively cultivated and relatively thin soils characteristic of the area. In spite of this fact, the above-mentioned pre-modern hollow way, which is part of a radial pattern of routes spreading out from the central site of Jerahiyah, can be traced westward for more than five kilometres (on CORONA images and on the ground) before fading out to the north of Tell Beban (site 167). A cautious dating of its formation to the Early Bronze Age — a period that witnessed intensive hollow way formation in Northern Mesopotamia (Ur 2003; 2010; Wilkinson 1993) — through its association with Jerahiyah's settlement history is suggested. Jerahiyah, however, is a multi-period site and its hollow way system could therefore have remained in use during later periods. This particular, long hollow way may have been connected with similar features located close to other archaeological sites west of Jerahiyah (Figure 4.14), such as the approximately two-kilometre-long hollow way passing to the north of Tell Sharafiyah (site 46),[12] which is aligned with the hollow way that starts from Jerahiyah. A further hollow way, over six kilometres long and with the same alignment, has been detected immediately south of the Chiya-i Dekan cairn fields. Less than three kilometres to the north of the point where it fades out, another hollow way leads to the major site of Gir-e-pan, an important 15 ha 'central' site that was inhabited without interruption from the mid-3rd millennium to the Neo-Assyrian Period and is characterised by a typical pattern of hollow ways radiating out from it.

Taken together, all these lengths of hollow way seem to suggest that a wide-ranging, interconnected hollow way system may have crossed the region in an east–west direction, linking the Jerahiyah plain sites with those lying in the plains of Gir-e-pan and, further to the north, Dohuk.

A Least-Cost Path determination, performed with an ArcGIS 10 extension (Spatial Analyst),[13] to track the most effort-effective route between the two major archaeological sites of Gir-e-pan and Jerahiyah[14] has shown that significant segments of the calculated itinerary coincide to a remarkable degree with the above-reconstructed regional hollow way route crossing the plain, starting from Jerahiyah (Figure 4.14). Since the various pre-modern hollow ways identified from CORONA images do not constitute a continuous (or necessarily contemporaneous) system, caution is required. However, it seems hard to believe that this correspondence between theoretical least-cost path and existing hollow ways is only a fortuitous coincidence. It is also noteworthy that the least-cost path and the possible network of interconnected routes linking Jerahiyah and Gir-e-pan cross the plain in an east–west direction immediately to the north of the observable distribution of ancient settlements in the plain. In fact, with the exceptions of only the first and last stretches of this reconstructed hollow way system (connected to the sites of Jerahiyah and Gir-e-pan respectively), these routes are not parts of networks of radial features, but rather linear tracks belonging to a regional communication route that seems not to have served the single sites scattered in the plain. In other words, in the Transtigridian piedmont plain communication patterns between the ancient urban centres of Jerahiyah and Gir-e-pan seem not to have followed the system of interconnected networks of wide-ranging radial roads centred on individual sites that has been well described by Ur in the Upper Khabur basin (Ur 2010: 133–134), but were rather based upon longer-distance inter-site pattern.

In its central and western segments, the reconstructed least-cost route and the surviving hollow way system between Jerahiyah and Gir-e-pan run parallel to the

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[11] I wish to thank Alberto Savioli, topographer, and GIS and remote-sensing expert of our project, for his insightful and untiring work on the analysis of satellite pictures (mainly 1967 and 1969 CORONA photographs, 2003–2005 OrbView-3 panchromatic images with 1 m resolution, and 2004 SPOT images with a resolution of 2.5 m).

[12] A 3.5 ha mound continuously occupied from the Late Chalcolithic until the Islamic Period. A new analysis of CORONA photographs (especially Missions 1039, February 28, 1967, and 1104-2138, August 16, 1968) and intensive fieldwork conducted in the area at the bottom of the mound have shown the existence of a lower city surrounding the tell. This lower city brings the overall surface of the site to 13 ha, making Sharafiyah one of the largest sites in the LoNAP survey region. The ceramic surface assemblages gathered suggest that Sharafiyah became important within the regional settlement system in the mid-3rd millennium BC.

[13] The ArcGIS Cost-Path tool determines the least-cost path from a source to a destination point, permitting the identification of the cheapest route relative to the cost units defined by the original cost raster that was input into the weighted-distance tool (considering mainly two parameters: slope and land use). This method — adapted from town planning, location and human geography studies — implies a component of decision-making in the construction of early communication routes and the deliberate application of the principles of minimisation of effort and maximisation of yield that are hardly conceivable in pre-modern societies. Nevertheless, its application as a heuristic tool to explore ancient patterns of movement with caution can be informative.

[14] Both sites belong to the largest size class detected in the LoNAP region (Figure 4.15) and can be assumed to have played an important role in the overall settlement system. Gir-e-pan may probably be identified with Assyrian Talmuššu/Talmussu, capital of a Middle and Neo-Assyrian province (Kessler 1987; Parpola and Porter 2001: 17; Postgate 1995: 11; Radner 2006: 43–44, 48; Reade 1978: 157–161; but for an alternative, though less probable, identification of Talmussu with Jerahiyeh, see Jacobsen and Lloyd 1935: 39).

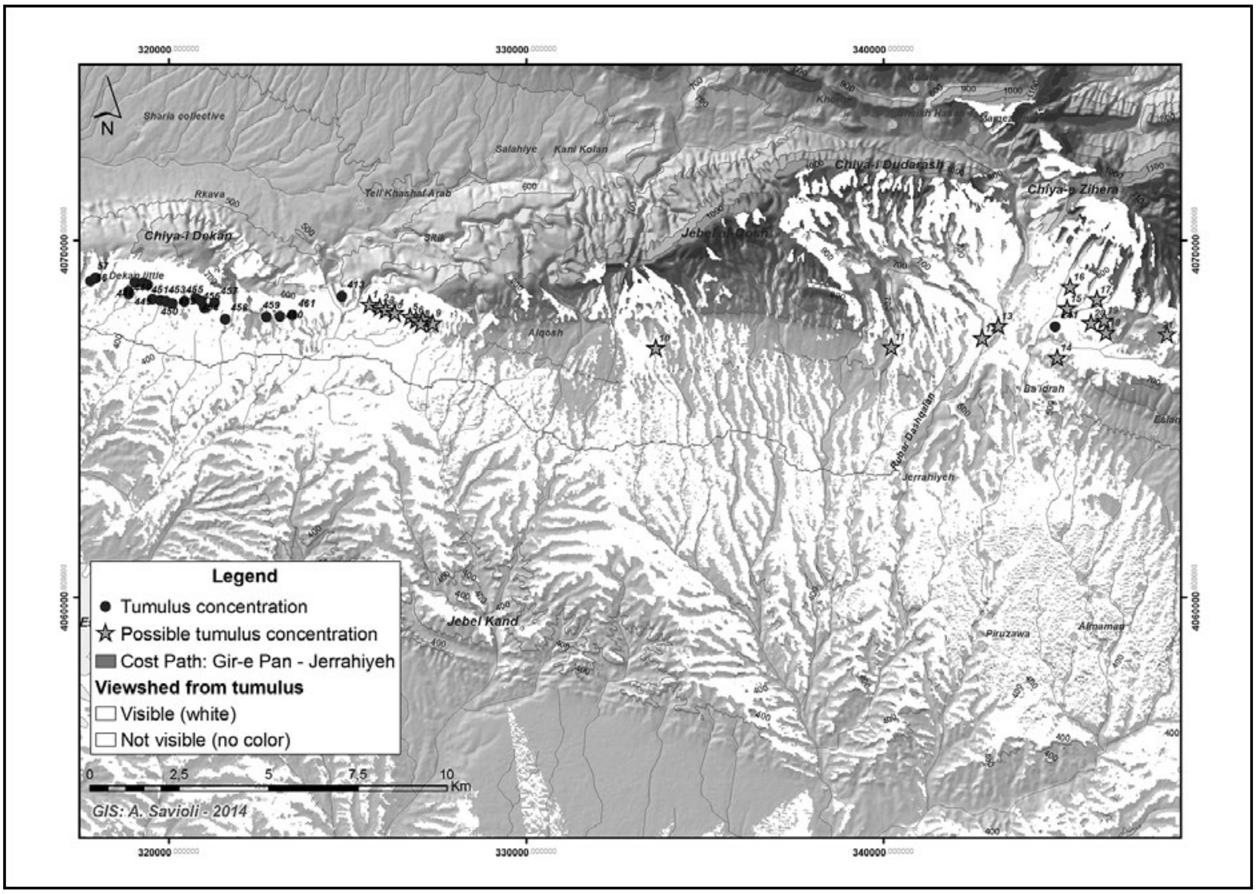

Figure 4.16. Viewshed from the cairn fields.

Jebel Al-Qosh and Chiya-i Dekan cemeteries, at a distance of only 1–1.5 km from the cairns. A Viewshed Analysis[15] indicates that all cairn clusters and fields in our area were easily visible from the least-cost path (Figure 4.16) and the penultimate long hollow way stretch of the pre-modern itinerary linking Jerahiyah and Gir-e-pan (Figure 4.14).

Taken as a whole, the available evidence shows the existence of a long distance east–west route and a separate set of north–south routes going through the smaller valleys of the Zagros piedmont that were used by transhumant groups. The distribution of pastoral cemeteries indicates clearly that the cairn fields and clusters of the Transtigridian piedmont belt were confined to a very specific setting and occupied highly visible positions that could easily be seen from and were perhaps (but not necessarily) closely connected with the main regional communication route crossing the northernmost part of the Nineveh hinterland that linked the two major sites of Jerahiyah and Gir-e-pan.[16]

The tumuli were probably not only commemorative funerary monuments, but also important landscape markers concentrated at the valley outlets, along possible transhumance itineraries linking the winter grazing lands of the Nineveh Plain and the summer pastures in the Zagros foothills.[17] Thus, cairns in the LoNAP region seem to have shaped a burial landscape that — through its obtrusiveness and visibility — linked together the mobile pastoral and sedentary components of the local population, ideologically and symbolically, by visually anchoring the elusive landscape of the non-sedentary groups, with their cemeteries and transhumance tracks, to the cultural landscape of the sedentary communities.

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[15] Viewshed analysis is a common function of most GIS software. The analysis uses the elevation value of each cell of a digital elevation model (DEM) to determine a viewshed, i.e., the area that is visible from a specific location, thus establishing the visibility to or from a particular cell. LoNAP relied upon a DEM of the region with 30 m resolution produced by the Shuttle Radar Topography Mission (SRTM) ASTER Global DEM V2 (USGS Global Data Explorer) in 2011.

[16] In fact, the obvious place to build cairns would be on the detritus flows, where rock was easily available.

[17] The hollow ways detected from CORONA images in the sparsely settled Gir-e-pan/Sharia plain can perhaps be interpreted primarily as pastoral transhumance paths crossing this small and little populated intra-montane plain in a southeast–northwest direction and pointing towards the narrow Bandawai Gorge dividing the Chiya-i Dekan hills and the Jebel Al-Qosh, the outlet of which is flanked by remarkable concentrations of cairns.

In the absence of archaeological excavations, the question of the dating of these pastoral cemeteries remains open. As mentioned above, the association of the archaeological material present on the ground surface, such as lithics and pottery, with the cairns may not be considered certain. As Table 4.1 shows, archeological material was recovered only from the surface of five out of 22 surveyed cairn clusters and fields. In four cases (cairns 241, 446, 447, and 458), the collected sherds date to a single period (Middle Bronze Age, Neo-Assyrian, or Islamic), while in one case (cairn 57) a Neo-Assyrian sherd was found together with a few Islamic pottery fragments. The number of diagnostic sherds recovered is always low, and they date mainly to the Neo-Assyrian and Islamic Periods, i.e., to the points at which settlement was most widespread, and land use most intensive in the region, and which have been found in most of the detected sites. The presence on the ground surface around the cairns of a few sherds from these periods can probably be regarded as background noise.

As we have already seen, only cairn field 241 has produced a large number of dated ceramic fragments (26) belonging to the Middle Bronze Age. The substantial amount of pottery diagnostics of this period littering the ground between the 17 tumuli on top of the small hillock overlooking the Sheikhan- Ba'adreh road — and the absence of material dating to other periods — suggest the cautious attribution of this pastoral cemetery to the Middle Bronze Age, although only archaeological excavation will make it possible to confirm or reject this hypothesis.

Cuneiform sources, such as the Mari and Shemshara texts of the time of Samsi-Addu mention, in the region to the east and west of the Upper Iraqi Tigris, the Ya'ilanum, a poorly known Amorite tribe ruled by a king called Mar-Addu. This tribe lived in the lands of Nurrugum and Qabra and was defeated, slaughtered and eradicated through deportations by Ishme-Dagan immediately before the joint conquest of Qabra and Urbil (Erbil) by Dadusha, king of Eshnunna, and Samsi-Addu (Charpin and Ziegler 2003: 90–101; Eidem and Laessøe 2001: 23; Ziegler 2004: 24 and 2011: 149–150). During the reign of Samsi-Addu, the LoNAP region was certainly part of the local kingdom of Nurrugum, to which sites like Talmush (probably Ger-e-pan), Ninet/Nineveh, Shibanum=Shibanibe/Tell Billa, and Kilizum/Qasr Shemamok belonged (Charpin and Ziegler 2003: 77; Ziegler 2004; 2011). The capital city of the Land of Nurrugum, which according to Eidem and Ziegler spanned both banks of the Tigris to the north of Ekallatum, had the same name and must have been located to the east of the Tigris, as an unpublished Mari letter suggests (Charpin and Ziegler 2003: 97–99; Eidem 1985: 101 and no. 84; Ziegler 2004: 21). The city of Nurrugum was certainly well fortified, since it resisted the siege by Samsi Addu's army for almost a year, while Nineveh fell after a few weeks. As for the identification of Nurrugum, the results of LoNAP's survey and excavations make the central site of Gir-e Gomel in the Navkur Plain a very good candidate for its location.[18] After the conquest of the capital city Nurrugum, the land of the same name became part of the kingdom of Upper Mesopotamia and many inhabitants of Nurrugum were enlisted in Samsi-Addu's army. After this period, the Ya'ilanum tribe that lived in the region disappears from the cuneiform sources. Slightly later, during the 17th/early 16th century BC, the otherwise unknown Pizigarra, of probable Hurrian descent — either the ruler of Nineveh, or coming from this city — is mentioned in a fragmentary context of the preamble of the important Hurrian literary composition 'The Song of Release,' which mentions the destruction of Ebla (de Martino 2014; Neu 1996; Wilhelm 2001), suggesting that our region had passed under the control of an emerging Hurrian polity.

This is the general historical context against which we may set tumuli cluster 241, which can tentatively be dated to the Middle Bronze Age. It is nonetheless necessary to stress that a direct association of this cairn field with the Ya'ilanum Amorite tribe, which is associated with this region by the Mari and Shemshara texts, is not possible. Furthermore, we should bear in mind that only one of the 22 surveyed cairn fields

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[18] Gir-e Gomel is located less than 40 km to the northeast of Nineveh, almost in the centre of the fertile and well-watered Navkur Plain. As has already been observed above, it is the most prominent site not only in the Navkur Plain, but in the entire LoNAP study region. The intensive survey carried out at Gir-e Gomel indicates that during the Middle Bronze Age the site was densely occupied over its entire surface area of about 40 ha, making it the largest centre in the region (Morandi Bonacossi *et al.* 2018). Topographically Gomel is characterised by a steep upper mound (35 m) of 1 ha surface area located at the centre of what originally seems to have been an impressive semi-circular urban centre. Roughly, one third of the site in the west has been eroded away by the river. The present topography suggests that the lower town surrounding the central mound was fortified. Finally, a test trench excavated along the southwestern edge of the lower town has brought to light a Middle Bronze Age II burial area with vaulted baked brick chamber graves (Morandi Bonacossi *et al.* 2018, 88-99). The erosion of the lower town by the River Gomel has shown that the necropolis extended at least for several dozens of metres. Due to their location along the eroded site flank, the excavated burials had been partly plundered in recent times, but burial goods, like painted Khabur jars, miniature vessels and animal terracotta figurines, and personal ornaments such as a toggle pin were still found in the excavated graves. The architectural remains of a possible official building have been brought to light in the Gomel eastern lower town (Morandi Bonacossi *et al.* 2018, 120-132). The available archaeological evidence from Gir-e Gomel suggests that during the Middle Bronze Age the site was the largest — possibly fortified — urban centre in the region to the northeast of Nineveh and that it controlled a very rich agricultural plain along the main route connecting the Tigris Valley, to the north of Nineveh, with the Erbil/Urbil Plain. The existence of an elite burial area at the southern fringes of the site and of a possible palace building along the eastern edge of its lower town are further indicators of is a further indicator of the urban character of Gir-e Gomel during the 18th–17th centuries BC. In the LoNAP study region, no other major Middle Bronze Age centre has been detected.

and clusters has been tentatively dated. The overall chronological framework of the pastoral burial landscape that is emerging in the Transtigridian piedmont belt is far from clear, and it seems plausible that it spans a much longer period than the Middle Bronze Age alone. Since the first phase of settlement growth in the region began in the Late Chalcolithic (Morandi Bonacossi and Iamoni 2015), one might assume that non-sedentary groups started moving along vertical transhumance paths from the uplands of the Zagros foothills to the Transtigridian alluvial plains — as in many other regions of Northern Mesopotamia and the Levant — during the 4th millennium BC (if not earlier), and that this pattern continued in the following millennia. Only a programme of test excavations of several tumuli from different selected cemeteries will make it possible to disentangle the probably complex chronological pattern hidden behind these monuments.

Despite the chronological indeterminacy that still weighs on our understanding of the burial landscape of the Nineveh hinterland, and that prevents us from recording the complexity, internal articulation, and diachronic range of this phenomenon, we have for the first time identified archaeologically a substantial pastoral component of the regional population in the cultural landscape of Northern Iraq. The spatial distribution of the cairn fields and clusters detected, with respect to what was probably the main east–west route of communication through the region, and the settlements of the sedentary component of the population, reveals the close association between the region's mobile pastoral and permanent communities. At the same time, the location of the pastoral cemeteries at the junction of piedmont and lowland zones and valley outlets, and their visual relation with the hollow way system crossing the plain, show how profoundly non-sedentary groups were able to mark the landscape in the Land behind Nineveh. Once more the evidence gathered emphasises the symbiotic entanglement of 'enclosed nomadism' characterising dimorphic societies, consisting of both mobile and sedentary pastoralists and agricultural communities (Rowton 1974; 1976), in an environment such as that of the ecotonal transition between the non-cultivated landscapes of the Zagros foothills and the agricultural landscape of the Nineveh hinterland. Further archaeological fieldwork on mobile pastoralists in our study region will allow us to better understand the interaction between the settled communities and the herders roaming the extensive empty areas between the agricultural hinterlands of the major mounded sites dotting the landscape of the Land of Nineveh and the mountain ranges behind it.

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Mapping and Modelling the 'Invisible Dead': Reconstructing Demographics in the Ancient Near East

Jennie Bradbury and Graham Philip

Introduction

In spite of the fragmentary nature of the mortuary record, and acknowledgment of the manipulation of the dead by the living, mortuary populations are often viewed as a useful and reliable way of reconstructing past human demography and social organisation on a local basis (e.g., Binford 1972; Shay 1983: 27; Yasur-Landau 1992: 244; Zimmerman *et al.* 2009: 369). Conversely, there has been a tendency to steer away from tackling such questions at a regional scale and a general avoidance of 'big picture' approaches to the reconstruction and understanding of 'mortuary' populations. In the Near East this is partly due to the fragmentary nature of the archaeological record, as well as the legacy of 'object' based research which, until recently, rarely prioritised human skeletal material (Perry 2012: 457). While scholars in the region have begun to explore the landscape location, chronological and typological distribution of burial forms (e.g., Bradbury and Philip 2011; Carter and Parker 1995; Steimer-Herbet 2004) there have been few attempts to consider what might be missing or to question the apparently representative nature of our data. To some extent, quantifying the dead spatially and temporally might be viewed as a near-impossible task. The current authors were both inspired by, and privileged to work with, Tony Wilkinson in his efforts to combine multiple regional datasets to make broad statements on matters of settlement and landscape exploitation (e.g., Lawrence and Wilkinson 2015; Wilkinson 2003; 2004; Wilkinson *et al.* 2014), an experience that indicated to us the potential of a 'big data' study of the mortuary record. In particular, Tony's delineation of 'Zones of Preservation' and 'Zones of Attrition' (Wilkinson 2003: 41–43), which highlighted the necessity of building methodologies and techniques to quantify and interpret the uncertainties associated with the archaeological record, has shaped our approach to mortuary data. We have recently used such an approach to highlight the existence of distinctive regional trends in the space-time distribution of mortuary remains across the Levant (Bradbury and Philip 2016; 2017). The present paper, however, offers a more detailed consideration of three sites. This we offer on the basis that the identification of the 'gaps' in the mortuary record as it presents archaeologically, is a necessary step in a reconsideration of the role of the dead within living communities.

The demographic enigma

Studies exploring the living demography of past populations have often focused on the reconstruction of household size, occupation areas, and probable sustaining areas and subsistence yields (e.g., Widell *et al.* 2013; Wilkinson 1994). Studies of mortuary populations have, in contrast, focused on information that can be extracted directly from skeletal remains: individual health, nutrition, and age at death profiles (e.g., Ortner and Frohlich 2008). The extent to which we can combine these two approaches and reconstruct comprehensive demographic profiles based on fragmentary archaeological evidence is less clear. For the present discussion we have adopted a figure of 100 individuals per settled hectare (e.g., Wilkinson *et al.* 1994: 503) and an average age at death of 35 years, a value based on mortality curves for traditional agricultural societies (Chamberlain 2006: 67, fig. 3.7). While these figures might lead us to significantly underestimate, or in some cases overestimate (see below for further discussion), the possible population of a single site at any given time, they are useful as heuristic tools through which to begin to explore and compare the demographics of mortuary and living populations.

Numerous pitfalls exist when dealing with temporally variable and uncertain datasets: these are addressed in greater detail elsewhere (Bradbury *et al.* 2015; Lawrence, Bradbury and Dunford 2012). Methodologies used to represent/re-calculate frequencies over time can lead to flattening or potential false peaks within the data. For example, plotting the Minimum Number of Individuals (MNI) from a particular cemetery per 100-year block,[1] the practice followed here, can over-inflate the relative numbers. Conversely, the more intuitive approach of dividing the MNI by the length of that particular archaeological period is often more a reflection of our ability to characterise and date discrete periods, than a genuine aid to data quantification. For the purposes of this paper all graphs have been plotted using century-long time blocks, a technique that we have found useful for comparing settlement data across regions that use different systems of periodisation.

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[1] Based on each MNI for a given period having an equal likelihood of having occurred within each 100-year block within the period e.g., an MNI of 300 for the EB I (3500–3000 BC) would be plotted out as 300 individuals for each 100-year time block falling between 3500–3000 BC.

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These appear to us to represent one of the best ways to deal with 'big picture' data that require comparison of evidence across periods, sites, and regions where chronological precision and period names and attributions differ significantly (Lawrence *et al.* 2012 for further discussion).

Jericho

> '...seems to indicate that the Jericho tombs represent the entire population of the site.' (Yassur-Landau 1992: 245)

Extensive excavations have been carried out at Jericho (Tell es-Sultan) since the early 20th century (e.g., Garstang 1932; 1933; 1934; 1936; Kenyon 1960; 1965; Nigro 2009; Sellin and Watzinger 1913). Kenyon's work revealed substantial extramural cemeteries to the north and northwest of the settlement mound. Based on the possible presence of undiscovered tombs within the extramural cemetery areas, Kenyon (1965: 1) initially suggested that the mortuary population of Jericho could be twice as large as that excavated. The majority of investigators, however, have treated the mortuary population from Jericho as representative of, if not the entire population, at least a substantial proportion of it (e.g., Palumbo 1987; Shay 1983; Yassur-Landau 1992: 245).

Estimating the mortuary population (the extramural cemetery)

Work carried out by the 'Invisible Dead' Project has brought together data from Kenyon's original excavations with the work of Garstang (1932; 1933; 1934; 1936) and Sellin and Watzinger (1913). Values for the Minimum Number of Individuals (MNI) have been re-calculated in light of recent re-assessments (e.g., Shafiq 2010) and additional details have been recorded by the authors concerning the certainty levels associated with these estimations. While Jericho is famous for its extensive Early Bronze Age IV (EB IV) cemeteries (termed Intermediate Early-Bronze Middle-Bronze by Kenyon [EB.MB]), Figure 5.1 demonstrates that while the Minimum Number of Burial Features (MNBF) — the actual number of tombs in use — during EB IV was significantly greater than in the preceding EBA, the MNI (i.e., the actual number of interments) was lower.

This reflects, in the main, a shift in burial practices, from multiple successive interments in the EB I–III, in which each chamber could contain the remains of hundreds of individuals, to the predominance of single inhumations during the latter half of the 3rd millennium BC. The Middle Bronze Age (MBA) marks the return to multiple successive burial practices, a shift again easily detected by comparing the plots of MNI and MNBF (Figure 5.1). The modest number of late-2nd millennium BC (Late Bronze Age) burials would appear to reflect a potential decline in population, at least as inferred from settlement density, and perhaps also our lack of understanding of Jericho during this period (Bienkowski 1986).

Estimating the mortuary population (Spring Hill and intramural burials)

In addition to the extensive extramural cemeteries, a small number of intramural or 'on-site' burials were discovered at Jericho.

In addition to an unknown number of MBA burials excavated on the western side of Spring Hill by the Austro-German Expedition, mudbrick-built chamber tombs were uncovered during excavations (Sellin and Watzinger 1913: 70–71): these were recently restudied by Nigro (2009). Apart from the hundreds of Aceramic Neolithic burials, the only other burials documented from the tell itself are of MBA date (see Figure 5.2). These are few in number and could account for only a very small fraction of the probable MBA population. We suggest that these represent a burial practice that was deliberately made distinct from the MBA multiple successive burials in the extramural cemetery.

Comparing estimates for the living and the dead

To judge from the published excavation plans, the area within the EBA walls covered approximately 1 ha, and that within the MBA rampart (part of which appears to have been removed by the road that runs along the east side of the present tell), around 1.8 ha (Kenyon 1981: figs 3 and 4). Taking into account the amount of space taken up by the ramparts, an occupation area of circa 1 ha or below for the EBA and 1.5 ha for the MBA would appear sensible. The extent of the on-site EBIV occupation (Kenyon's EB–MB) is difficult to estimate. While occupation of this period was reported from Trenches I, II, and III in the west, north, and south parts of the tell respectively, material from all three areas was of limited extent and characterised by the same greenish coloured mudbrick: no area produced evidence for more than two structural phases (Kenyon 1981: 107–108, 166–167, 213–215). By analogy with the evidence from other tell sites, the EB IV occupation is likely to have been quite modest in scale (Mazar 2006).

Settlement/activity during the LBA is also poorly understood; occupation during this period was possibly restricted to the Middle Building area (Bienkowski 1986). Relatively little evidence for earlier MBA material (MB I) has been documented from the site and, apart from a handful of burials, it is likely that main period of MBA occupation is of MB II, a period to which we assign two centuries.

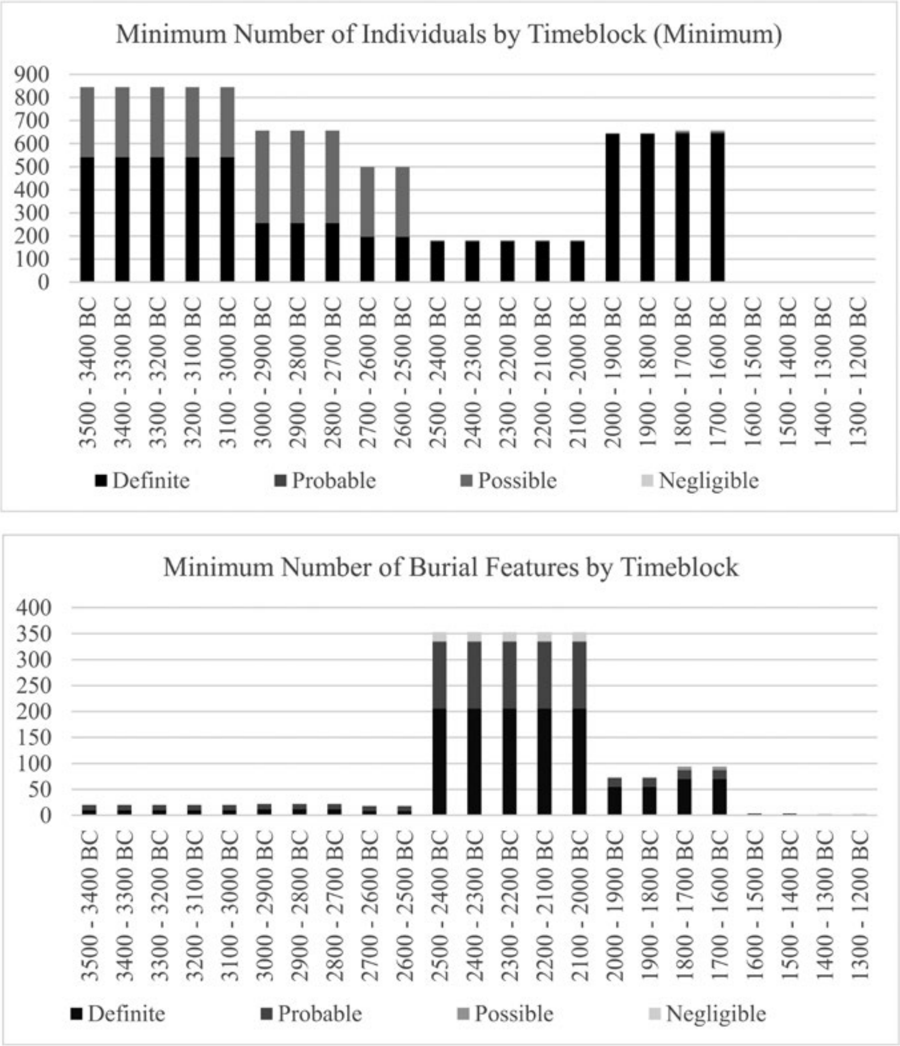

Figure 5.1. Minimum Number of Individuals (MNI) and Minimum Number of Burial Features (MNBF) from Jericho extramural cemeteries (4th–2nd millennium BC).

Comparing the figures collated by the Invisible Dead Project for the extramural cemetery (based on tomb contexts which have been definitively dated and contained skeletal material) we would be dealing with circa 80–120% of the total estimated population for the EB I–III and MB II (Table 5.1). Given these figures and Kenyon's (1965: 1) suggestion that on space grounds it might be possible to increase the number of recorded burial locales in the extramural cemetery by around 100%, and making allowance for tombs in which associated skeletal material and/or artifactual evidence was absent, we suggest that the mortuary population in these graves appears likely to have included a substantial percentage, if not all, of the living population. In contrast, using the same figures to calculate the proportion of the population represented by individuals from the settlement mound/Spring Hill (and assuming that all the material assigned to MBA should be dated to MB II) we are dealing with no more than of 1–2% of the estimated living population. Had excavations at Jericho been restricted to the tell our reconstructions would, therefore, be very different. The site of Jericho is remarkable for the degree of preservation and extent of excavations. However, as shall be explored below, it is perhaps more unusual than previously envisaged.

Megiddo

Located on the eastern flank of the Carmel Range, modern Tell el-Mutesellim (ancient Megiddo) has been the subject of significant excavations since the early 20th century (Guy and Enberg 1938; Lamon and Shipton 1939). Although a figure of 50 ha has been cited for the EB IB settlement at Megiddo (Finkelstein and Ussishkin 2000: 583–584), the figure of 12 ha, cited by the Megiddo Hinterland Project a few years later (Finkelstein *et al.* 2006: 721), appears more credible — see also Braun (2013: 1). Occupation dating to the MBA–LBA appears to have encompassed the entire site, including the

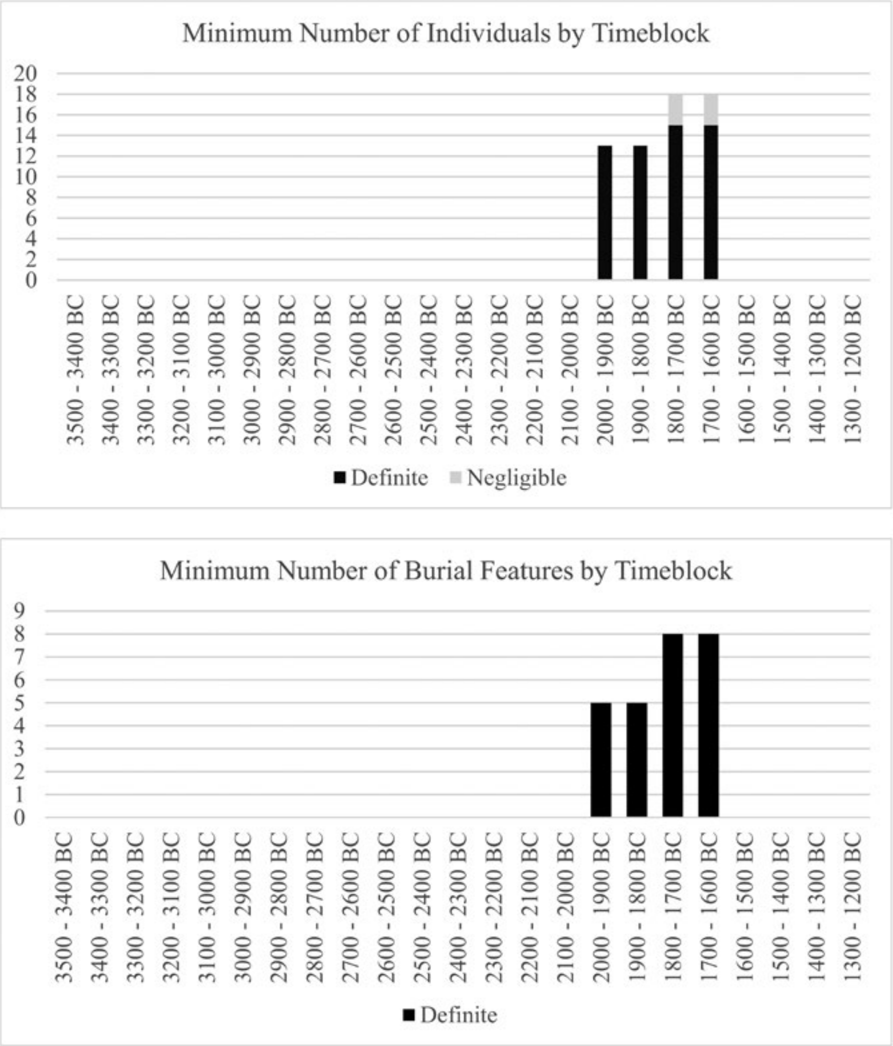

Figure 5.2. Minimum Number of Individuals (MNI) and Minimum Number of Burial Features (MNBF) from Jericho intramural burials (4th–2nd millennium BC).

lower terrace, a total of around 12 ha, although the site may have attained 13.5 ha in the later MBA (Arie 2008: 11). Excavations on the central mound revealed burials (intramural) in Areas AA and BB (Loud 1948: 15, 87–98), while substantial extramural cemeteries of different periods were identified on the eastern slopes of the mound (e.g., Arie 2008; Guy and Engberg 1938; Ilan 2013).

Estimating the mortuary population (the extramural cemetery)

If we compare the plots in Figure 5.3, two main patterns are visible. Firstly, there would appear to be a decrease in the number of burial features from the late 4th into the 3rd millennium BC (EB II material, as traditionally defined in Northern Palestine, is absent at Megiddo), followed by a significant increase in numbers during the 2nd millennium BC, with a peak in the LBA II (1400–1200 BC). The MNI plots, however, show a completely different trend, with values decreasing significantly at the end of the 4th millennium BC and only increasing in any significant manner during the LBA I (1600–1400 BC). In other words, from the beginning of the MBA (circa 2000 BC), while we see an increase in tomb cutting/construction, the number of individuals being deposited within, or at least recovered from, each tomb appears to have declined.

Estimating the mortuary population (main tell)

Compiling numbers for the MNBF and MNI from the settlement mound of Megiddo reveals similar patterns to Jericho. While skeletal remains pre-dating the MBA have occasionally been recovered, these are not found in association with deliberate burial constructions/ features (Figure 5.4) but represent skeletal material intermixed with general occupation layers/deposits. The relationship between the MNBF and MNI plots demonstrates two diverging trends: an increase in the

Table 5.1. Estimated figures for population over time compared against values for the MNI.

Period	Total Estimated Population	MNI (Min)	% of Est. Population	MNI (Max)	% of Est. Population
100 individuals per hectare, 1.0 ha (EB I–III) 1.5 ha (MBA) and life expectancy of 35 years (Period length/35 year life expectancy) x (100 individuals x estimated site size) e.g., EB IB = (300 years/35 year life expectancy) x (100 individuals x 1 ha) = Total Estimated Population of 857					
EB IB (3300–3000 BC)	857	848	98	1048	122
EB II (3000–2700 BC)	857	657	77	1057	123
EB III (2700–2500 BC)	571	500	88	700	123
MB II (1800–1600 BC)	857	648	76	649	76
MB II (1800–1600 BC) Spring Hill	857	7	0.8	18	2
NB. These figures include Garstang's Tomb A (MNI of 300–500 individuals) dated to EB I–III, this figure is taken as a possible MNI for EB I, II, and III					

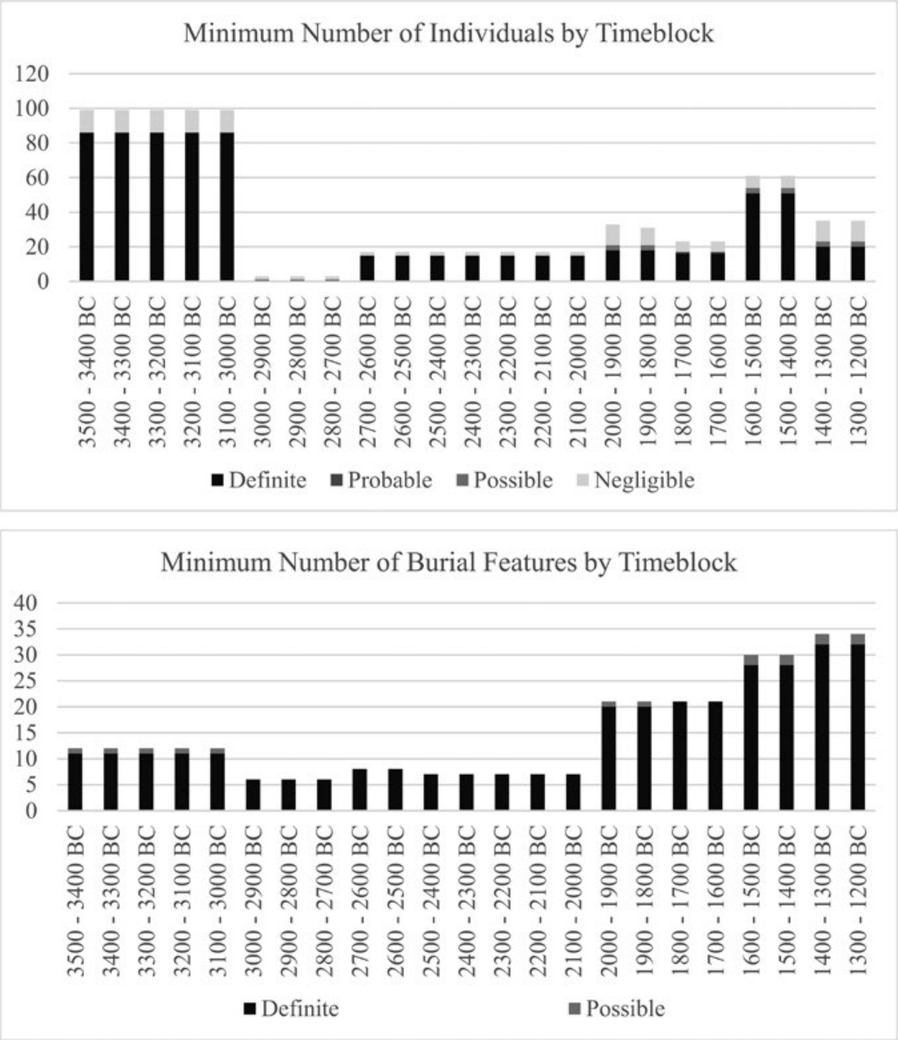

Figure 5.3. Minimum Number of Individuals (MNI) and Minimum Number of Burial Features (MNBF) from Megiddo extramural burials (4th–2nd millennium BC).

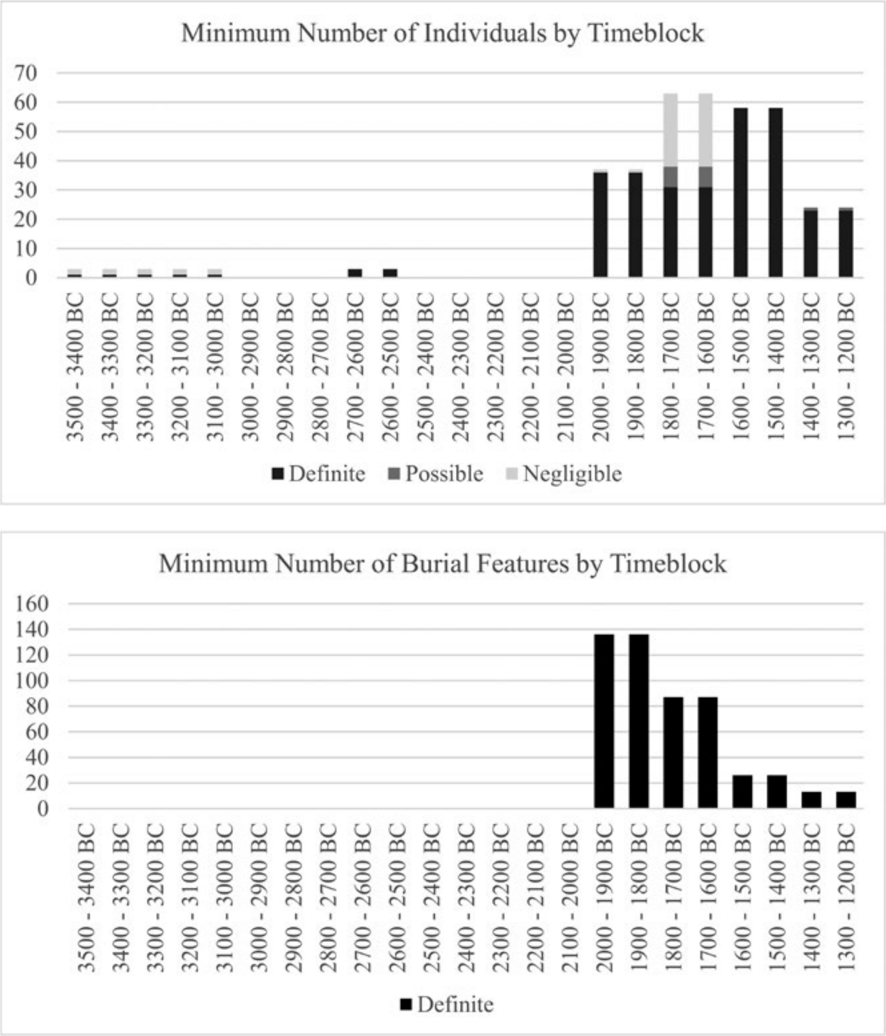

Figure 5.4. Minimum Number of Individuals (MNI) and Minimum Number of Burial Features (MNBF) from Megiddo intramural burials (4th–2nd millennium BC)

MNI during the latter half of the MBA, at the same time as a decrease in the MNBF. It is likely that, as at Jericho, this reflects the dominance of multiple successive burial practices during this period, although perhaps not on the same scale as during the Early Bronze Age in the extramural cemetery. Having said this, we also have to take into account the fragmentary nature of the data from Megiddo and the early date of excavations. There are multiple cases, both pre- and post-dating this phase where we know the numbers and forms of burial features, but have no corresponding data on the skeletal material. What is apparent, however, is the shift at the beginning of the MBA, to the use of both extramural and intramural locations for burial of both adults and children.

Comparing estimates for the living and the dead

Throughout all time periods at Megiddo we appear to be dealing with a tiny proportion of the expected mortuary population, a figure of 0.03–1.74% based on the current evidence and calculations. The proportion of the dead appears to increase during the latter half of the 2nd millennium BC, although due to the fragmentary nature of the evidence our estimates of numbers per burial may be significantly underestimated, especially for earlier periods (i.e., EB I). It is perhaps significant, however, that there is a decline in burial numbers in the 3rd millennium BC, a period during which, at least in the Southern Levant, our evidence for burial practices appears to be much more restricted in comparison to the earlier 4th millennium BC (see below for further discussion).

Qatna

Located along the Wadi Zora, Tell Mishrifeh (ancient Qatna) is a key site for interpretation of urban development in the Northern Levant during the later 3rd and 2nd millennia BC. Excavations and survey

Table 5.2. Estimated figures for population over time compared against values for the MNI.

Period	Total Estimated Population	MNI (Min) Tell and Cemetery	% of Estimated Population	MNI (Max)	% of Estimated Population
100 individuals per hectare, 12 ha and life expectancy of 35 years (Period length/35 year life expectancy) x (100 individuals x estimated site size)					
EB IB (3300–3000 BC)	10286	87	0.846	102	0.991
EB II/III (2900–2500 BC)	13714	18	0.131	20	0.146
MB I (2000–1800 BC)	6857	54	0.788	68	0.99
MB II (1800–1600 BC)	6857	47	0.685	86	1.25
LB I (1600–1400 BC)	6857	109	1.590	119	1.74
LB II (1400–1200 BC)	6857	43	0.627	59	0.86
100 individuals per hectare, 13 ha and life expectancy of 35 years					
EB IB (3500–3000 BC)	11143	87	0.780	102	0.915
EB II/III (2900–2500 BC)	14857	18	0.121	20	0.135
MB I (2000–1800 BC)	7429	54	0.727	68	0.92
MB II (1800–1600 BC)	7429	47	0.633	86	1.16
LB I (1600–1400 BC)	7429	109	1.467	119	1.60
LB II (1400–1200 BC)	7429	43	0.579	59	0.79

carried out between 1924 and 2010 (du Mesnil du Buisson 1935; Morandi Bonacossi 2007; Pfälzner 2007; Pfälzner ed. 2011) have allowed at least a partial picture of the urban organisation of the site to emerge. The earliest evidence for occupation, dating to the 4th millennium BC, was revealed by a trial trench carried out in Operation J (Morandi Bonacossi 2007: 66).

Following a hiatus in occupation, the summit of the upper town appears to have been re-occupied during EB III (Morandi Bonacossi 2007: 66) and by EB IV occupation seems to have extended across an area of at least 25 ha (Morandi Bonacossi 2007: 70). The city reached its zenith during the 2nd millennium BC (Morandi Bonacossi 2007: 70–71) and by the beginning of the MBA appears to have gained its recognisable quadrangular plan, with settlement and activity extending to circa 100 ha (Morandi Bonacossi 2007: 70–71). It is estimated that only around 5% of the overall area of occupation at Qatna has been systematically investigated; the majority of work has focused on the upper town (Morandi Bonacossi 2007: 66). From this area we have evidence for EB IV shaft tombs, excavated by du Mesnil du Buisson (1935: 155–158) in the early 20th century, as well as MBA burials (du Mesnil du Buisson 1927: 13–22; Morandi Bonacossi 2011) and the famous MBA–LBA Royal Tombs (Pfälzner 2011; 2014).

Estimating the mortuary population

One of the major challenges posed by the Qatna material is the poor preservation of many of the remains and the re-use of burial locales over extended periods of time. As Pfälzner (2011; 2014) and his team have demonstrated, the Royal Hypogeum of Qatna and Tomb VII may well have been in use for several centuries, with skeletal material being transferred from one location to another. If we also take into account the early excavation date of the EB IV shaft tombs (du Buisson 1927) and the damage to some of the MBA tombs and associated skeletal material (Morandi Bonacossi 2011: 28), it is clear that estimates might significantly underrepresent the mortuary population of this city.

No tombs or burials pre-dating the EB IV period been reported from Qatna and the earliest evidence for mortuary activity is roughly contemporary with the development of the site as a 25 ha settlement, in the second-half of the 3rd millennium BC (see Figure 5.5). The MBA cemetery, discovered by the Italian mission, appears to have consisted of a mix of shaft tombs and pit graves, the majority of which were single inhumations (Bonacossi 2011). The full extent of this cemetery, destroyed by the construction of the Royal Palace of Qatna, is not known and much of the skeletal material appears to have been disturbed due to construction of the MBA Palace (Bonacossi 2011: 11).

Comparing estimates for the living and the dead

Given the relatively limited area of excavation, uncertainties surrounding the nature of occupation and the evidence for disturbance and longevity of use of some of the burial locales, comparisons between

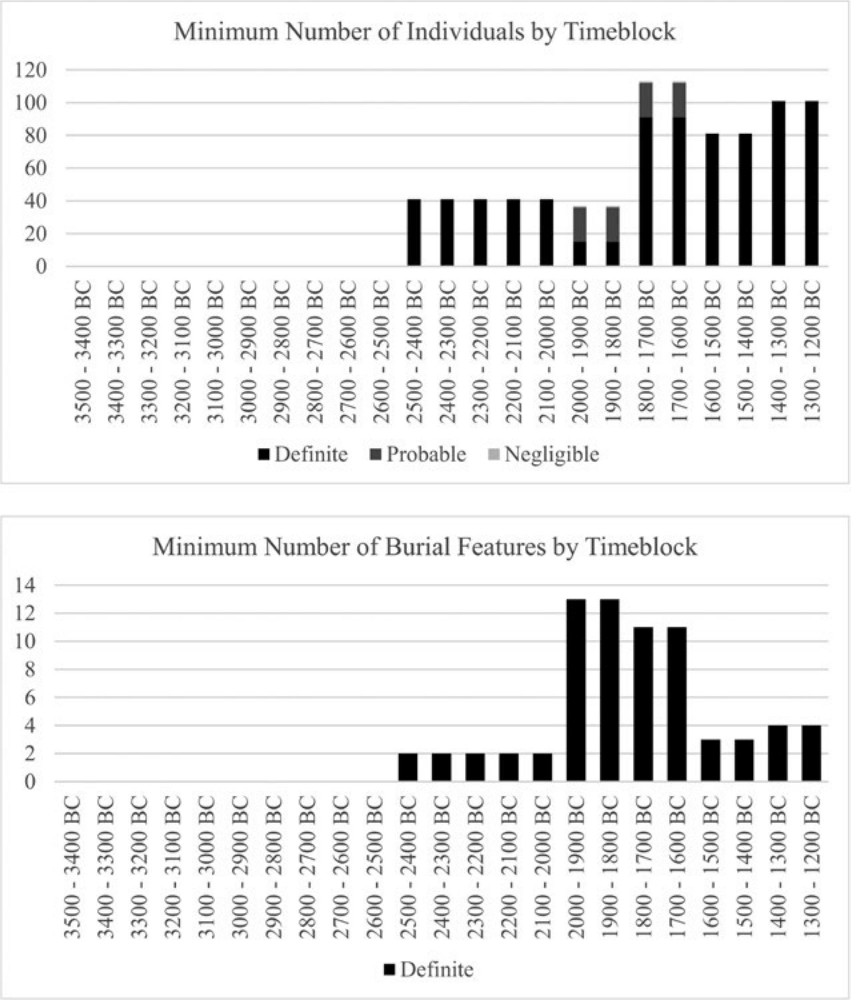

Figure 5.5. Minimum Number of Individuals (MNI) and Minimum Number of Burial Features (MNBF) from Qatna (4th–2nd millennium BC).

the living and mortuary populations are problematic. While the total area encompassed by the fortifications during the 2nd millennium BC attained circa 110 ha, Qatna may have been a 'hollow city' (Bonacossi 2007: 80) during the LBA, a site occupied by numerous administrative and public buildings with a relatively low residential population. If this was the case, reconstructions based on a density of 100 individuals per ha may result in a grossly inflated figure. However, even if we reduced the average population per ha to 50 individuals for the LBA, based on the current rates of burial retrieval and extrapolating from the 5% that has been excavated to the unexcavated 95%, we would still have evidence for well under 2% of the overall expected mortuary population (see Table 5.3). As at Megiddo, the dead at Qatna are severely underrepresented in the archaeological record.

Mapping and modelling the 'bigger picture'

The fragmentary nature of the material discussed here will come as no surprise to many readers. What is, perhaps, less expected, is the extent to which our knowledge is limited and the considerable proportion of the dead that appears to be missing from the existing archaeological evidence. The key issue is whether this is simply a case of missing evidence due to patterns of excavation and survey, or whether there are additional factors that need to be acknowledged.

Recovery patterns versus burial traditions

Recovery patterns, excavation strategies, and the intensity of fieldwork across the Levant will clearly have influenced the overall percentage of dead recorded from the archaeological record. A plot of the distribution of burial evidence (Figure 5.6) highlights the marked bias towards the Southern Levant and in particular modern Israel and Palestine. However, this is what would be expected given that research has been far more intensive in these areas compared to other parts of the Levant, and that they both offer reasonable access to online publications and databases (see Bradbury *et al.* 2015 for further discussion). When the

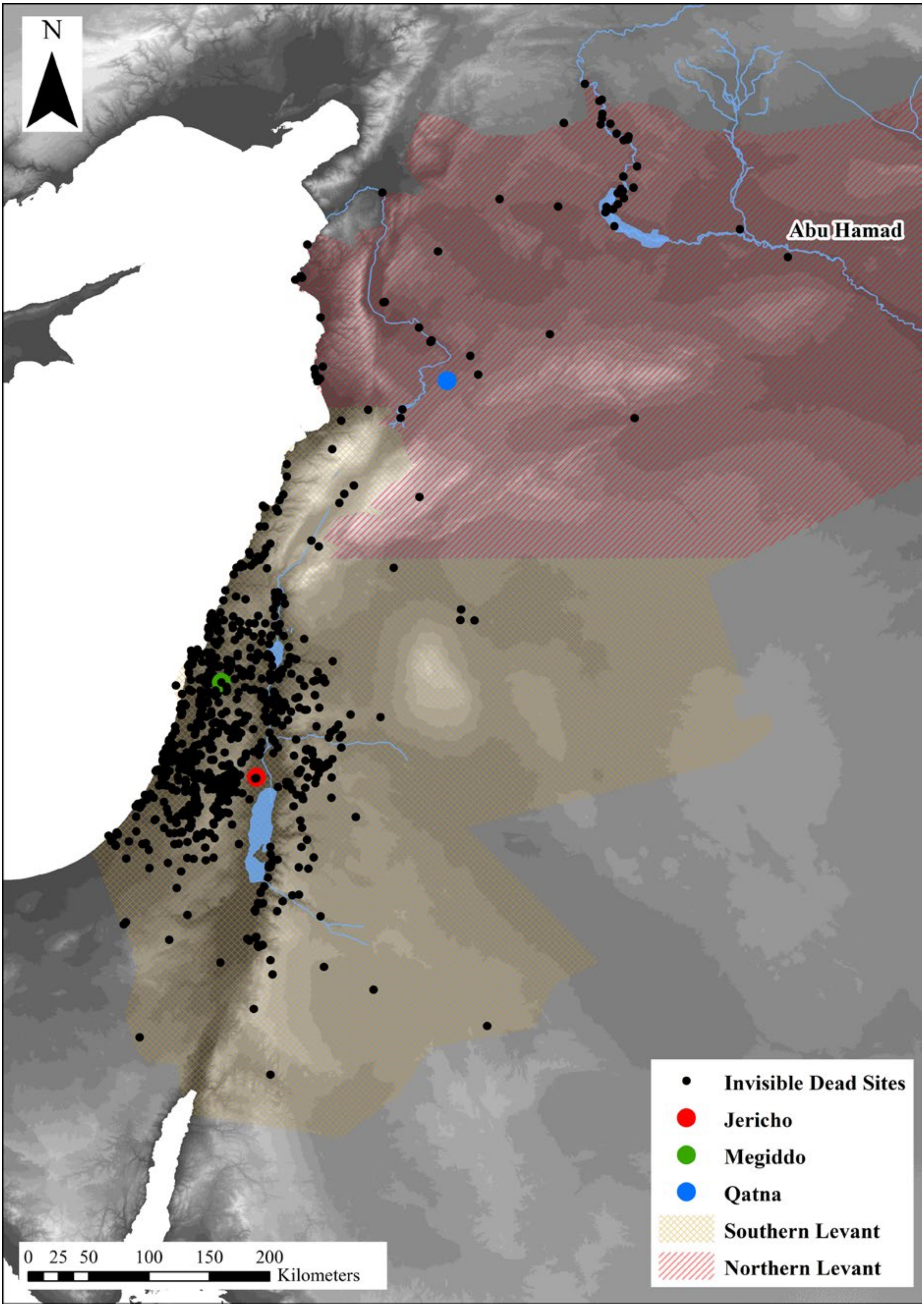

Figure 5.6. Sites recorded by the Invisible Dead Project (all periods) with the sites of Jericho, Megiddo and Qatna marked

extant burial evidence is considered, are these factors enough to account for the:

a. extreme differences between north and south,
b. degree of temporal variation,
c. marked divergences between individual sites?

The discovery and excavation of an extensive extramural cemetery at Jericho may well account for the high mortuary population documented from this particular site. Extramural cemeteries from the east slopes of Megiddo (e.g., Guy and Enberg 1938; Ilan 2013) have also been extensively excavated and even when combined with the areas of intramural burial cannot account for more than 2% of the expected mortuary population. Are we then dealing with a situation whereby, for certain periods and certain sites, only selected individuals or groups within society were allowed burial, at least in a way that is archaeologically visible?

North versus south: linking mortuary and settlement evidence

By plotting out MNIs drawn from the Invisible Dead database across the study region over time and space (Northern versus Southern Levant) and comparing this information with known settlement patterns and trends, we can detect possible phases when the dead, relative to the settlement record, appear to be highly visible and, conversely, phases when they appear to be largely 'invisible'. The Southern Levant is defined here to include Lebanon, the Damascus Basin, and Hauran, while the Northern Levant for the purposes of this study includes everything north of this point as far east as the Euphrates and the site of Abu Hamad (Figure 5.6). For Figures 5.7–5.9 we have only included MNIs where the period of attribution is definite and have taken minimum rather than maximum figures for sites where a min–max MNI range has been specified. All MNI figures, whether listed as Definite (e.g., an osteoarchaeological evaluation and likely MNI has been suggested) or Negligible (e.g., skeletal material has been recorded, but the data on MNI is not reliable) (and see Bradbury *et al.*, 2015 for further discussion of these certainty levels), have been included in the analysis.

The extent to which a single site can influence distribution plots is immediately apparent. The massive concentration of burials at the EB I site of Fifa southeast of the Dead Sea, which has produced some 10,000 cist graves (Kersel and Chesson 2013: 161), distorts the temporal distribution of the dead in the Southern Levant and disguises more subtle fluctuations (compare Figures 5.7 and 5.8). Even when removed, however, it is clear that this cemetery is indicative of a more widespread pattern, whereby the numbers of dead recorded in the archaeological record drop significantly in the Southern Levant from the 4th to the 3rd millennium (from EB I to EB II–III). A second and perhaps more intriguing observation is the clear divergence in MNI between the Southern and Northern

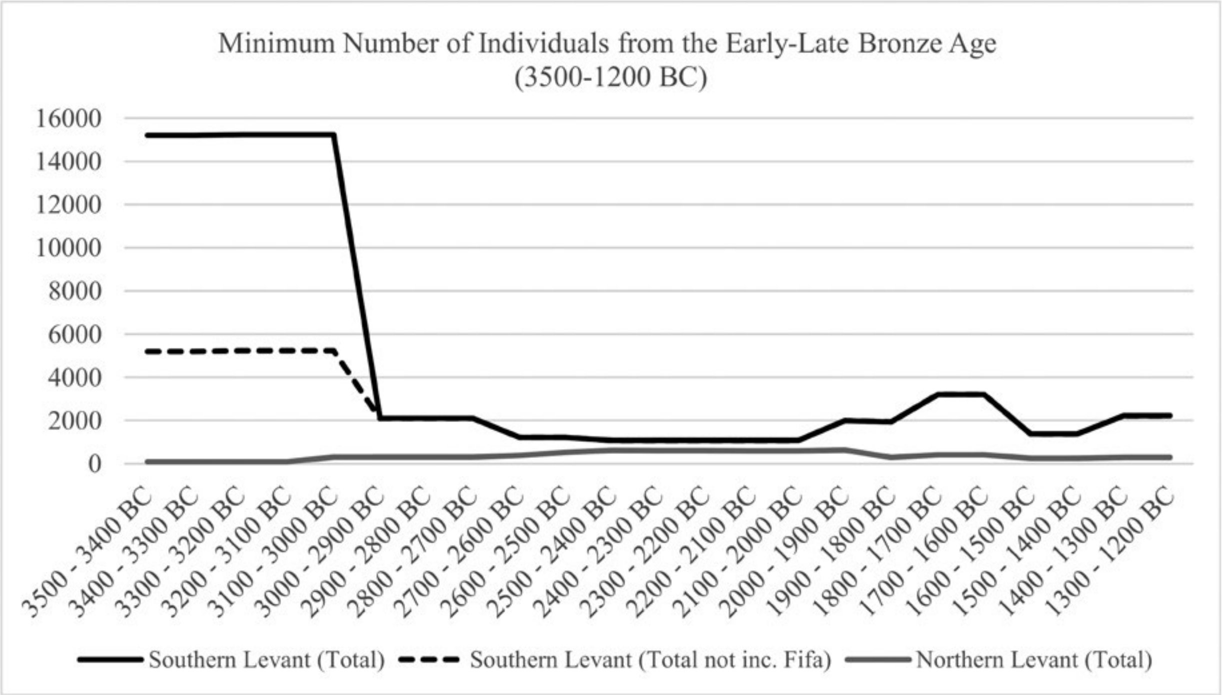

Figure 5.7. MNI plotted out by 100-year time block from the Northern and Southern Levant.

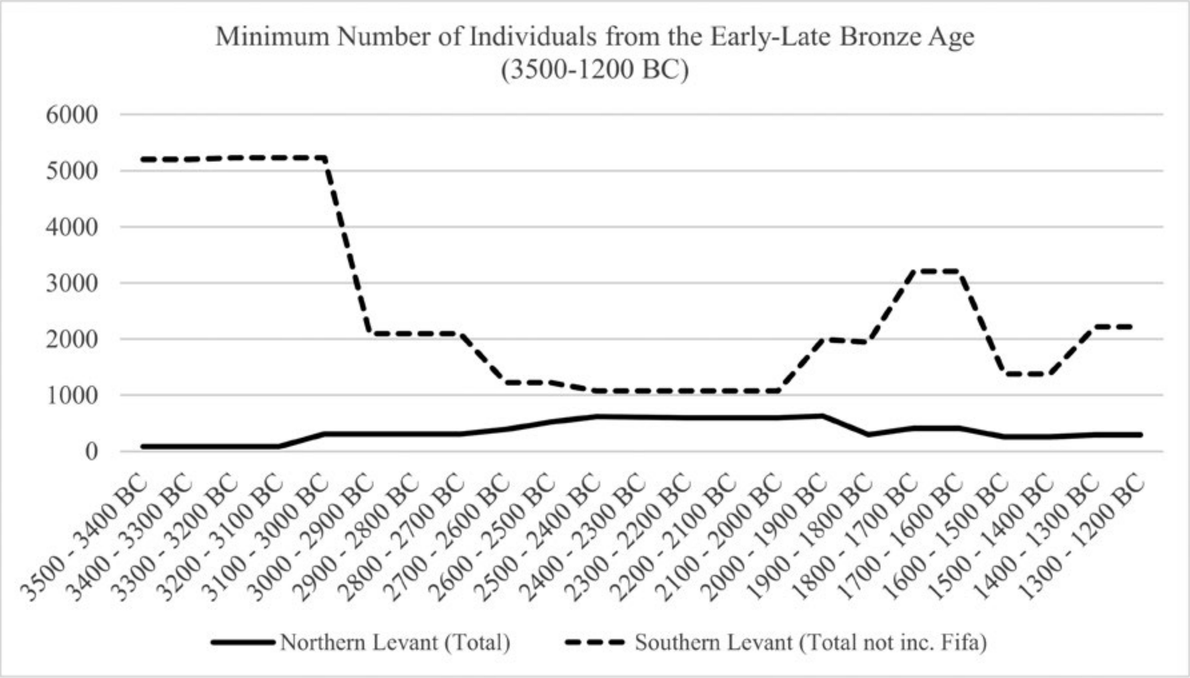

Figure 5.8. MNI plotted out by 100-year time block from the Northern and Southern Levant. The cemetery of Fifa with circa 10,000 possible burials has been excluded from this plot.

Levant over time. Not only are the numbers of recorded dead from the Southern Levant significantly greater than those from the Northern Levant, the two regions also reveal different mortuary profiles, particularly during the 3rd millennium BC.

If patterns of fieldwork were solely responsible for these distributions, we might expect the divergences between the two regions to be fairly consistent over time. If we disregard the absolute figures from the two regions and instead express the mortuary population for each area, at any given time slice, as a percentage of the overall total for the Levant (Figure 5.9) it is clear that this is not the case. Instead, it may be possible to suggest that there are several different factors influencing, not only the numbers of dead in the archaeological record, but also their relative distributions. It should be noted that because we have used time blocks (i.e., based on the total MNI for a given period having an equal likelihood of having occurred within each 100-year block), the figures here cannot be interpreted cumulatively. To put it simply, we are concerned here with the relative distributions and patterns rather than the absolute figures produced by the plot. Three broad phases can be identified (Figure 5.9). The first begins in the second-half of the 4th millennium BC, when the relative percentage of dead in the Southern Levant significantly outweighs that from the Northern. The situation shifts during the later 3rd and early 2nd millennia BC, with the relative percentages of dead in the Northern Levant increasing substantially during the EB IV and early MBA Periods, while the opposite pattern can be observed in the South. It is not until the 2nd millennium BC (from circa 1900/1800 BC) that the two regions appear to come into step with one another.

The later 4th millennium bc in the Southern Levant: expansion and networks of interaction

The later 4th millennium BC saw human groups exploit regions such as the steppe and uplands in new ways and at a previously unprecedented scale (e.g., Bradbury *et al.* 2014; Müller-Neuhof 2014; Nicole and Braemer 2012; Philip and Bradbury 2010; Wilkinson *et al.* 2014). At the same time larger population centres emerge, for example in the north Jordan Valley (Wilkinson *et al.* 2014: 88). How far these new centres correspond to traditional models of stratified urban existence has been a matter of some debate and researchers have recently begun to construct models of corporate, multi-resource societies, with shifting and flexible groups coming together at different levels of social interaction (Bradbury *et al.* 2014; Nicolle and Braemer 2012). Within such loosely structured societies, burial practices may have been a medium through which group cohesion could be expressed and articulated (Bradbury *et al.* 2014: 225). The elevated burial numbers in the Southern Levant may represent flexible and multi-resource groups, utilising particular micro-regions (e.g., the Dead Sea region), and for whom social cohesion was

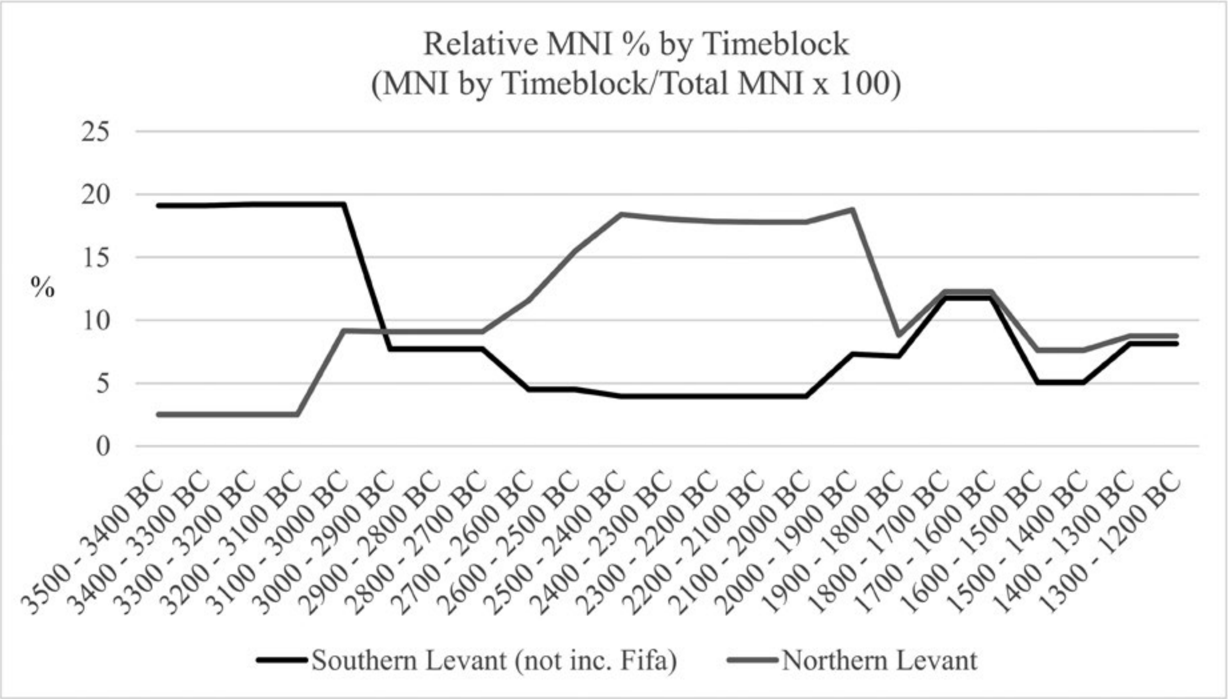

Figure 5.9. MNI by 100-year time block plotted as a % of the overall MNI numbers from all periods from each region.

partly maintained through the integration of the dead into large corporate groupings. The question, then, is why do patterns change at the beginning of the 3rd millennium BC? With the exception of sites such as Bab edh-Dhra and Jericho, there is significantly less evidence for EB II–III burials within this region than for EB I (Ilan 2002: 97). As with Jericho, Bab edh-Dhra may represent a fairly unique site in this respect, with charnel houses from the EB II–III housing hundreds of individuals organised on a corporate household model (Chesson 2003). Outside the confines of the Dead Sea region, the growing nucleation of population within walled settlements, often in prominent locations (Philip 2003: 114–115), may have reduced the importance of burial, or at least the burial of a significant proportion of the population, as a means of inscribing the community into the landscape. It is possible that growing social differentiation during the 3rd millennium BC served to restrict the proportion of the community that it was deemed appropriate to bury, with this practice no longer considered a fundamental element of social reproduction.

The 3rd millennium bc in the Northern Levant: expansion and individualisation

During the 3rd millennium BC the visibility of the dead in the Northern Levant significantly increased, in particular at sites in the Euphrates Valley. Based on recorded MNIs, burial activity reaches its peak during this period and similar mortuary population figures are not seen again until well into the 1st millennium BC. This amelioration would appear to coincide with a phase in western Syria, which has come to be known as the ‘Second Urban Revolution’. This period witnessed the growth of urbanised centres along the Euphrates and Khabur, with subsequent expansion and activity into the climatically marginal steppe during EB IV in western Syria. The process appears to have taken place several centuries earlier in the Western Jazira (Wilkinson *et al.* 2014: 93, Table 4). The burial practices dating to this period vary and include richly furnished single or double inhumations such as that from Qara Quzaq (Olávarri 1995: 15–23), rich multiple successive burials such as Tomb 302 at Jerablus Tahtani (Peltenburg 1999), and the deposition of disarticulated commingled skeletal remains such as those recovered from the White Monument at Tell Banat (Porter and McClellan 1999). The co-existence of these different burial forms may, as Porter (2002: 169) has suggested, represent the interplay and possible emerging tensions between ancestral tribal and emerging state elements or, articulated slightly differently, individualising and communal tendencies within society. As Wilkinson *et al.* (2014: 82–84) have demonstrated, settlement and activity during the mid–late 3rd millennium BC in the Northern Levant was dynamic. The burial practices reflect this; groups and individuals were negotiating power structures and identity in new ways, for example through the increasing deposition of metal objects and weapons in the burial record (Philip 2007: 194–195; Stork 2015) and at new scales and levels of intensity.

One of the remaining questions, however, is why we have so little evidence for 4th millennium BC burial practices. Urbanisation in northeast Syria extends back well into the 4th and 5th millennia BC (e.g., al-Quntar et al. 2011; Stein 2012; Ur *et al.* 2011), but apart from offsite burials at sites such as Tell Brak (McMahon *et al.* 2011) and sites further east such as Tepe Gawra (Akkermans and Schwartz 2003: 190), there is little or no published evidence for adult burial practices from the Late Chalcolithic Period. In this respect the 3rd millennium BC in the Northern Levant, and particularly in northwestern Syria and the Euphrates Valley, stands out as a period of burial intensity and innovation.

The 2nd millennium bc: regional powers and control?

From the beginning of the 2nd millennium BC, both the Northern and Southern Levant appear to come into step with one another. While elevated burial figures are apparent during the second-quarter of the 2nd millennium BC (MB II), the mortuary populations of both regions do not return to the levels of either the 4th (Southern Levant) or 3rd (Northern Levant) millennia BC. We are faced with a period when the mortuary evidence appears to be telling a distinct and divergent story from that of the settlement record. The early–mid 2nd millennium BC in the Southern Levant has traditionally been characterised as a phase of re-urbanisation (Cohen 2014: 451). In the Northern Levant the evidence points towards a patchwork of regionally diverse settlement trajectories (Morandi Bonacossi 2014: 416–420). With this 'big picture' in mind, if we once again consider the mortuary population from Qatna, the proportion of the probable dead who appear unrepresented in the archaeological record is even more striking. Our knowledge of the lower town of Qatna during the MBA is undoubtedly very imprecise (Morandi Bonacossi 2007: 74, fn. 44). If, however, we take the cemetery discovered from the upper town as broadly indicative of the burial practices for both high status (shaft graves) and less elevated persons (pit graves) for adults, children, and infants (Morandi Boncassi 2011: 34), we can extrapolate from the excavated 5% of site to the unexcavated 95%. Tomb I, a MBA shaft tomb excavated by Mesnil du Buisson (1927: 13–22) in the 1920s, has yielded evidence of at least 21 individuals. Although the material encountered in this tomb was highly fragmentary and the MNI as reported may have been significantly underestimated (du Mesnil du Buisson 1927: 14), we can use this as a guide-figure for the maximum number of individuals we might expect on average. To account for 100% of the estimated mortuary population posited for MBA Qatna (see Table 5.3) we would need to discover a cemetery, or group of cemeteries, containing at least 3000 shaft tombs, each containing at least 21 individuals. The majority of tombs excavated by Morandi Bonacossi (2011: 14) were single inhumations and if this pattern were applicable across the site we would have to identify tens of thousands of burials of this kind to account for the estimated population. This leads us to ask whether it is more likely that such a large cemetery, or collection of cemeteries, exists somewhere in the lower town, or perhaps in an as yet unidentified extramural location in the vicinity of Qatna, or that the dead were being buried, or otherwise disposed of, in a manner that is not archaeologically visible.

At the broad scale, the decreased visibility of the dead seen from the MBA continues into the LBA. It might be suggested that the development of large regional polities, and the associated network of connections and affiliations that characterised the socio-political world of the Late Bronze Age (Akkermans and Schwartz 2003: 327), may have resulted in growing restrictions on the categories of person that were accorded a formal burial, at least of a kind that would become archaeologically visible. This is not to suggest that this process occurred in a uniform manner and at exactly at the same time across the entire Levant. As sites such as Jericho demonstrate, substantial portions of the overall population, in some places at least, may still have disposed of their dead in an archaeologically visible manner. Even at Jericho, however, we see control emerging through a different mechanism, via the ability to dictate where different individuals or groups could be buried (e.g. off- and on-site).

The 'big picture' and remaining questions

This paper represents a somewhat speculative attempt to interrogate the mortuary record at a 'big picture' scale. It is has endeavoured to show how, by exploring spatial and temporal discontinuities in the mortuary record and individual settlement biographies, we can reveal new and intriguing avenues for future investigation. Numerous questions remain; for example, to what extent is our use of MNI blurring further patterns and how do differential patterns of skeletal preservation, documentation, and discovery bias our interpretations? Are well-excavated cemeteries, such as Jericho, distorting the picture or do they provide examples of sites that may diverge from regional trends? Perhaps one of the most fundamental questions that still requires an answer is exactly who are we seeing in the mortuary record? Research has illustrated the differential visibility of groups such as children (e.g., Nagar and Eshed 2000) within society. Archaeological accounts appear to suggest that for the majority of periods the available burial record provides a representative sample of elite and non-elite burials (e.g., for the Middle Bronze Age: Akkermans and Schwartz 2003: 322; Genz 2012: 624–625). However, in light of the sheer numbers of dead that are missing from the archaeological record as currently known, we should perhaps question current assumptions, and view the treatment of the dead in the Bronze Age Levant as protean. We need to research more intensively those practices which would not necessarily lead to archaeologically visible remains; for example, disposal of the dead in water, the scattering of cremated remains, exposure of the dead in the open air, or shallow 'topsoil' burials in the agricultural landscape. These disposal methods should not necessarily be seen as the antithesis of a 'proper burial'. Whatever hypothesis we use to account for the 'invisible' dead, it is possible that at some space-time loci, the key constitutive element of an elite burial was not the grave goods, but simply the right to a burial at all.

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The Gorgān Wall's Garrison Revealed Via Satellite Search: Sasanian Fort Design in Northern Iran

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The late Tony Wilkinson's research has been hugely influential on many archaeologists, and the authors of this report have learned a great deal from him. One of them (EWS), while having previously employed aerial photography and other remote sensing techniques, had never used satellite images in his research before. This changed after his co-authors and he embarked upon a fieldwork project on the Gorgān Wall with Tony Wilkinson. The great potential of the method, pioneered by Tony Wilkinson, soon became very clear. Not only, as amply demonstrated before (e.g., Wilkinson 2003), could it shed much new light on settlement patterns, agriculture, and irrigation over time, it could also revolutionise our perception of the military infrastructure and capabilities of empires. While relevant evidence features in our recent fieldwork report (Sauer et al. 2013: 178–243), this volume in memory of Tony Wilkinson provides an appropriate occasion not only to update our results, but also to include important new findings and the visual evidence, much of which has been omitted from the monograph and may well be its greatest lacuna. This paper was originally delivered on 10 January 2014 in Tony's presence and was intended for his Festschrift. His departure on 25 December 2014 has been an immense loss, and without his inspiration this paper would never have been written.

The discovery of Sasanian military barracks on the Gorgān Wall

In our joint Iranian and Edinburgh- and Durham-based project (2005–2009), we explored the Gorgān and Tammisheh Walls in Northern Iran, defensive barriers which reach a combined length of over 180 km, as well as the associated military sites and frontier landscapes. Prior to this project, little had been known for certain about the Sasanian Empire's standing army, as reflected by many recent hypotheses on its alleged small size, disorganisation, or even non-existence (e.g., McDonough 2011: 299–301, 306; McDonough 2013: 603–604). Some assumed the defence of this mega-empire, stretching from Mesopotamia to the western edge of the Indian Subcontinent (Figure 6.1) for four centuries (3rd–7th centuries AD), relied largely or exclusively on levies of unprofessional peasant soldiers. Radiocarbon samples recovered and dated in 2005 yielded proof for what was then a minority opinion, that the Gorgān Wall with its over 30 forts (Figure 6.17) was indeed a Sasanian creation. Yet, ultimate proof for the organisation of the army behind this massive project was still outstanding. Were the large forts perhaps designed to be occupied only at times of crisis and otherwise empty, as once suggested to us and as Mohammad Chaichian (2013: 75–76, 85) and Scott McDonough (2013: 611) still believe today?

Even prior to our fieldwork such an interpretation did not seem likely, and Mohammad Yousef Kiani's major fieldwork on the Gorgān Wall had revealed structures, mostly of mudbrick, in Fort 13. (The report (Kiani 1982b: 19–22, with figs 12–15) refers to excavations in Fort 12, or Forts 12–13, but the plans and aerial photos suggest that the trenches were in Fort 13 (Kiani 1982b: figs 10, 12, 14, pls 4.2–4.3, 6–8, cf. fig. 3; Kiani 1982a: 75–76, fig. 2, pls Ib, III).) Little, however, could be said then about the dimensions of these features, their plan, and density of occupation. This changed in 2006 when magnetometer survey, led by Roger Ainslie of Abingdon Archaeological Geophysics, revealed parallel long narrow buildings in Fort 4 on the Gorgān Wall (Figure 6.2). The standardised simple design of double rows of rooms of similar size strikingly resembled army barracks as known from other armies, notably that of the Roman Empire (Figure 6.3). We subsequently observed that these long buildings detected via geophysical survey, within Fort 4, precisely coincided with long parallel ridges. Excavation revealed the reason for the formation of these massive earth mounds. The walls of the barracks consisted of mudbrick, were 1.20 m wide, and survived to a height of over three metres. Originally probably at least two storey high, rainwater eventually had led to their collapse (Figure 6.4) and similarly to that of equidistant towers around the perimeter. This created long parallel heaps of soil within a rectangular platform, with tower mounds dotted along the edges (other than the side of the robbed-out Great Wall built of reusable fired bricks), and a geometric pattern that matched the original layout of the fort.

Fort 4 was not a one-off. Not only were there rational reasons to guard all forts on all segments of the long barrier, rather than just one fort or a few, concrete evidence soon emerged that parallel long mounds, similar to those observed within Fort 4, filled each and every well-preserved fort on the Wall. One fort north and one, ESE of Fort 14 and a third, SSE of

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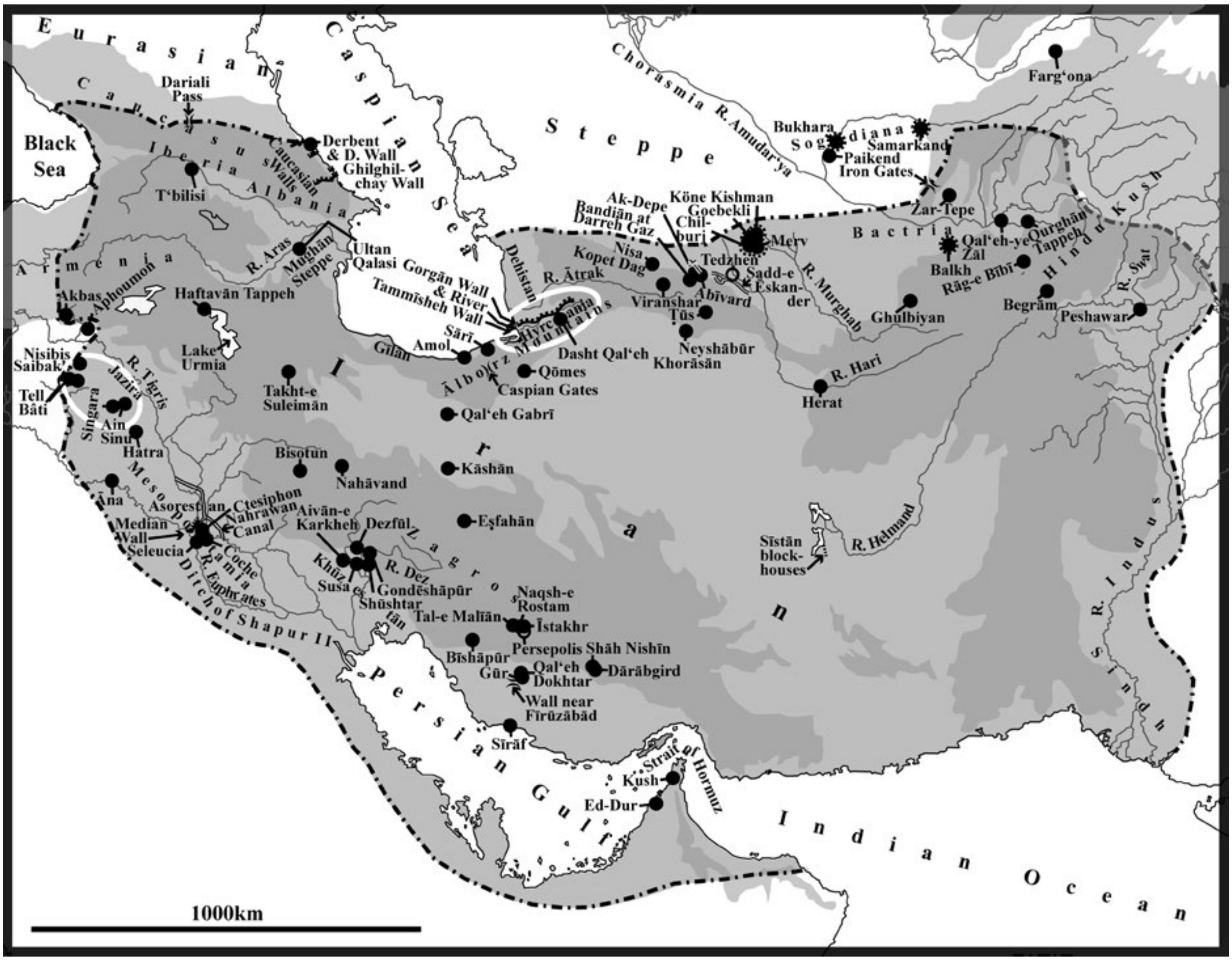


Figure 6.1. Known Sasanian barracks cluster so far exclusively in two areas (encircled in white) of the Sasanian Empire (here in its approximate boundaries of circa AD 480, with earlier and later sites and monuments), both key conflict zones, in or at the edge of arid land, without suitable settlements for reuse.

Fort 17 without traces of barracks are exceptions to the rule. None of them abuts the Gorgān Wall and they are perhaps all medieval in date (Wilkinson *et al.* 2013: 131 no. 228; cf. Kiani 1982b: figs 3–4). Now conscious of the pattern, we were often able to spot these parallel oblong ridges when visiting a fort. They emerged more clearly, however, when systematically examining satellite images. Not only were they much more obvious on these photos from above than when observed from a terrestrial perspective, it was also clear that mechanised agriculture was increasingly taking its toll. A set of CORONA images purchased on Tony Wilkinson's initiative proved our greatest asset. These images of the late 1960s revealed earth mounds since ploughed flat and no longer visible on the ground today or on recent Google Earth images. Even the still fairly numerous earth mounds not yet completely obliterated by the plough or earth-moving machinery showed up more clearly on these historic images than on recent photos.

Mesopotamian parallels

We had not been the first to spot these mounds, but it was only after our the detection of the ancient barracks via magnetometer survey, excavation, ground-truthing, and satellite search, that we became aware of them featuring in a small number of recent publications. The first, to our knowledge, who referred in print to the existence of such parallel mounds within the Gorgān Wall forts was Shelagh Gregory (1997: 178–179). She observed the existence of raised strips and recognised their similarity to barracks forts in Upper Mesopotamia:

> 'Two other Mesopotamian sites, one near Tell Brak ... and one c. 30 km to its west, which look very similar to the Ain Sinu 'barracks' when seen from the air, appear to have rows of barrack blocks only and no adjacent base for administration ... A note of caution is needed in relation to these Mesopotamian sites as a very similar effect of raised strips can be

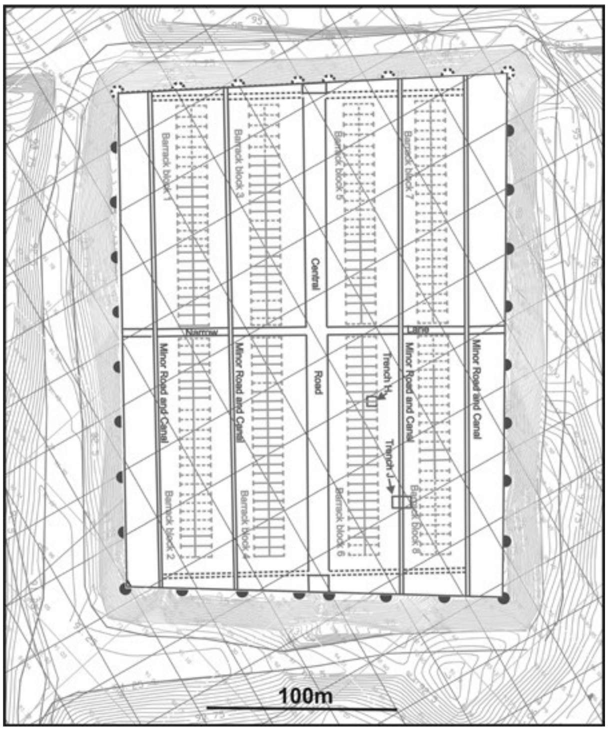


Figure 6.2. Barracks in Fort 4, based on geophysical survey by Abingdon Archaeological Geophysics, excavations and survey by the joint project and topographical survey by Seyed Hassan Hosseini. The Great Wall is at the top.

> seen in aerial photographs of forts placed along the linear defence known as Kizil Yilan (Red Snake), or 'Alexander's wall', which runs east from the south-east corner of the Caspian Sea (Schmidt 1940: pl. 65) ...'

Gregory had spotted these 'raised strips' on the cited aerial photographs of Forts 15 and 16 (Figures 6.5–6.6) published by Erich Schmidt more than half a century before.

Schmidt had been, to our knowledge, the first to publish photos of long mounds in two forts on the Gorgān Wall, taken on May 12, 1937 (Schmidt 1940: 54–58, 60-61, pl. 65). As far as we can see, however, neither he nor Kiani, who published further impressive aerial photos of Forts 4 (Kiani 1982b: pl. 1.2 = Figure 6.7), 10 (Kiani 1982b: pl. 1.1 = Figure 6.10), 16 (Kiani 1982b: pls 2.1 = Figure 6.8, 3.3), and 29 (Kiani 1982b: pl. 2.2 = Figure 6.11), all with clear long mounds in their interior, comments on the existence or significance of these features. There is no doubt, however, that Kiani and his team had noticed these mounds, as the excellent plans (Kiani 1982b: figs 1–8b) of the Wall, evidently based on aerial photos, clearly show parallel strips, often in the correct number and orientation, in many of the forts. Already Schmidt (1940: 56–57, cf. pl. 65B) had concluded that the 'garrisons of the forts were inside the area to be protected' and that the 31 forts he had spotted once held 'the garrisons for this remarkable system of defense' perhaps implying that he had spotted and correctly interpreted the mounding in the interior, or perhaps just stating what seemed common sense: the mere existence of forts implied garrisons, unlikely to have camped outside unoccupied compounds.

Gregory published her work just one year after St John Simpson (1996: 90, 92) had made a very important observation on the Mesopotamian barracks forts: 'This raises the interesting possibility that hitherto rather puzzling remains from the T. Brak area may represent evidence of Sasanian rather than Roman or later military construction. They comprise ... a set of 'barrack-blocks' at Saibakh ... The plan of the latter closely resembles the ... 'barrack-blocks' at Ain Sinu ... the lack of convincing architectural parallels from comparable Roman military sites ... suggests that it may instead be of later or conceivably Sasanian construction.' In the light of the striking similarity of the barracks forts on the Gorgān Wall and those in Upper Mesopotamia, Simpson's proposed attribution of the Mesopotamian barracks forts to the Sasanian army is in all probability correct, even if more excavation in this currently inaccessible part of the world is needed to gain certainty. Both territories were under Sasanian

Figure 6.3. Roman barracks, while differing in dimensions and presence or absence of officers' quarters, tend to be of simple geometric design and consist of a row of rooms or double-rooms: reconstruction of Roman barracks (the long building in the foreground) at South Shields.

Figure 6.4. A deserted "ghost town" at Tinerhir in Southern Morocco (photos by Bernhard Epstein, left, and EWS, right). Collapsing mudbrick architecture not worth reusing is gradually resulting in the build-up of heaps of soil, the same well-known phenomenon we see in the barracks mounds in the forts on the Gorgān Wall.

rule for centuries (Figure 6.1) and, unlike Upper Mesopotamia, the Gorgān Plain has never been in the Roman sphere of control.

In Upper Mesopotamia, long mounds (Kennedy and Riley 1990: 213 fig. 167) similarly directly overlie excavated barracks (Kennedy and Riley 1990: 214, fig. 168; Oates 2005: 83, fig. 6).

Potential and limitations of satellite survey

Satellite search was essential for proving that barracks filled not just the odd fort, but virtually every well-preserved geometric lowland fort of the Sasanian era. This is not to say that we would have been able to reveal the function of these mounds without geophysical survey and excavation. Only the latter techniques allowed us to trace individual rooms and their entrances and to establish the date and nature of their intensive and permanent occupation, from the 5th (or early 6th) to the 7th century. The combination of all techniques was required to reveal function and architecture of the buildings and their omnipresence within geometric Sasanian forts. Indeed, it allowed us to show that the parallel mounds were collapsed buildings in the first instance rather than, for example, having been created in the course of hypothetical later ridge and furrow cultivation of well-drained fort platforms.

There is, however, one probable exception to satellite images showing just collapsed buildings, but not their internal and external walls. A systematic examination of satellite imagery of all forts on the Gorgān Wall revealed an unusual pattern at Fort 26 (Figure 6.9). Here we may see individual room units, whose size and linear alignment in double rows is very similar to the internal subdivision of the barracks in Fort 4. What is puzzling, however, is that cellular structures thought to represent rooms are not confined to parallel double rows, but also fill the space in between the hypothetical buildings, even if less neatly and geometrically. We are unsure how to explain this phenomenon. Perhaps

Figure 6.5. Four parallel long mounds in Fort 15, one of the two earliest published photos of barracks on the Gorgān Wall (Schmidt 1940: pl. 65A, courtesy of the Oriental Institute of the University of Chicago).

Figure 6.6. Aerial photograph of the Gorgān Wall and two barrack mounds in Fort 16 (Schmidt 1940: pl. 65B, courtesy of the Oriental Institute of the University of Chicago).

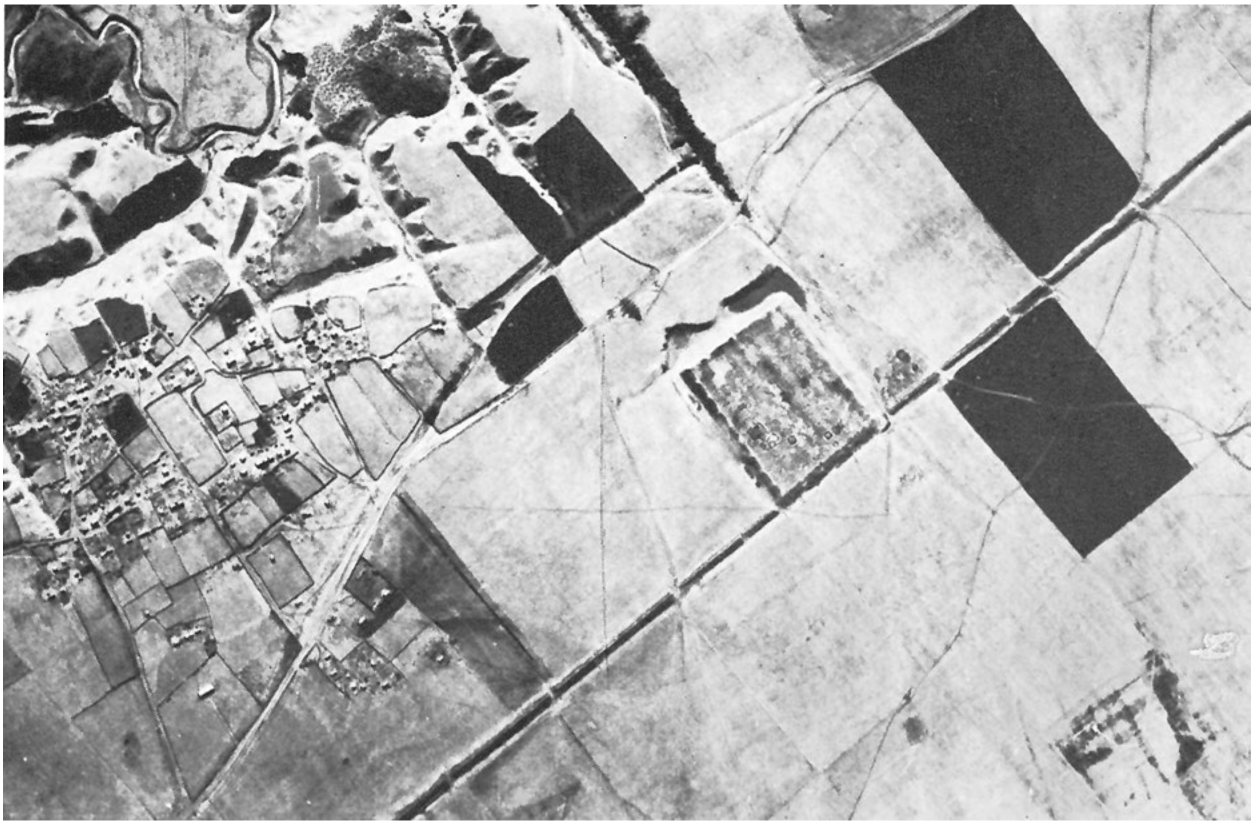


Figure 6.7. Barrack mounds an aerial photograph of Fort 4 published by Kiani (1982b: pl. 1.2, reproduced by kind permission of the Eurasia Department of the German Archaeological Institute and Dietrich Reimer Verlag).

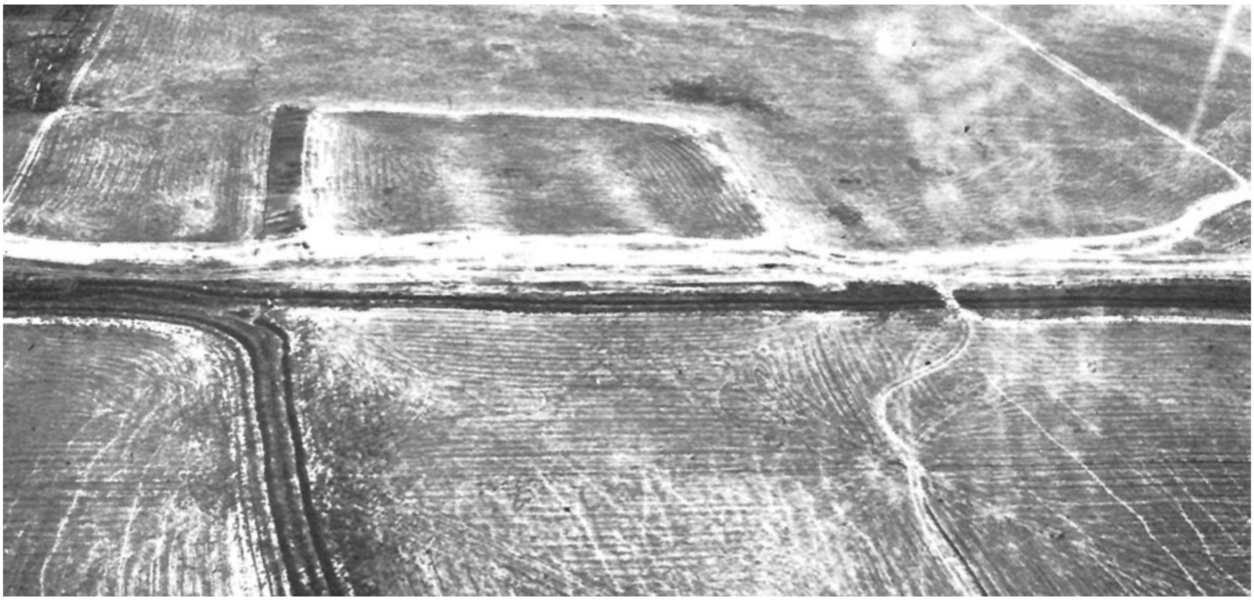


Figure 6.8. Barrack mounds on aerial photograph of Fort 16 published by Kiani (1982b: pl. 2.1, reproduced by kind permission of the Eurasia Department of the German Archaeological Institute and Dietrich Reimer Verlag).

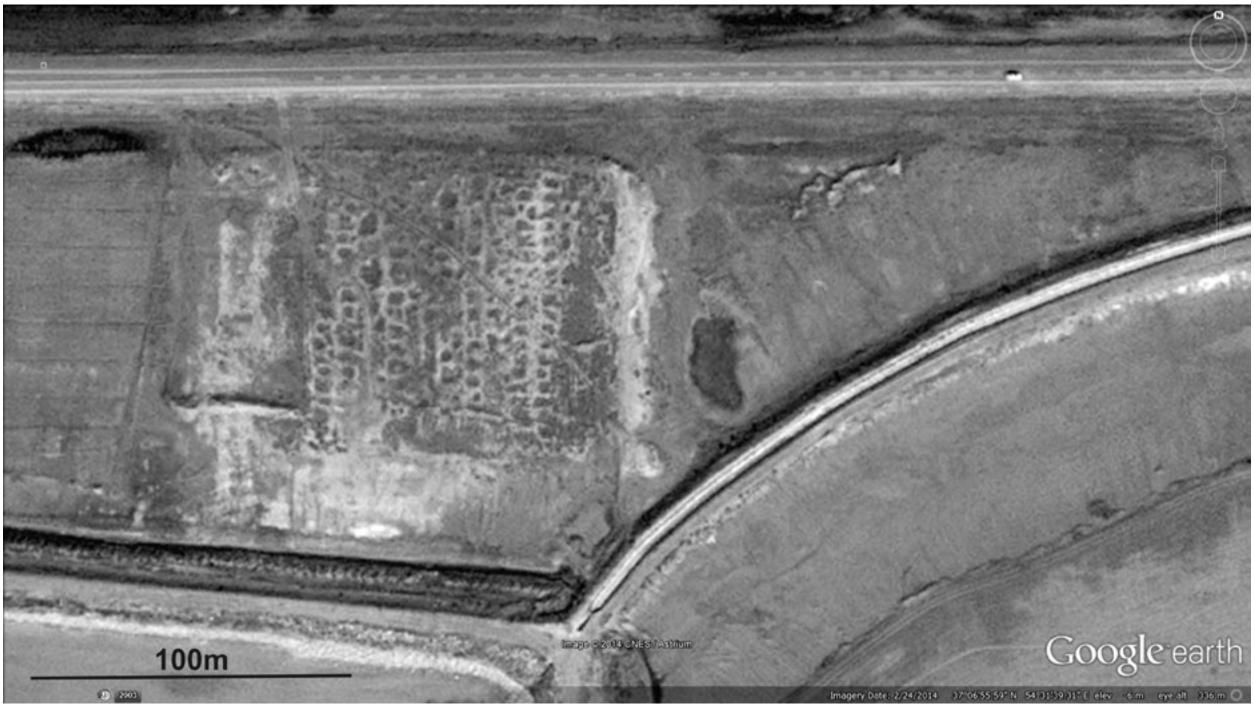


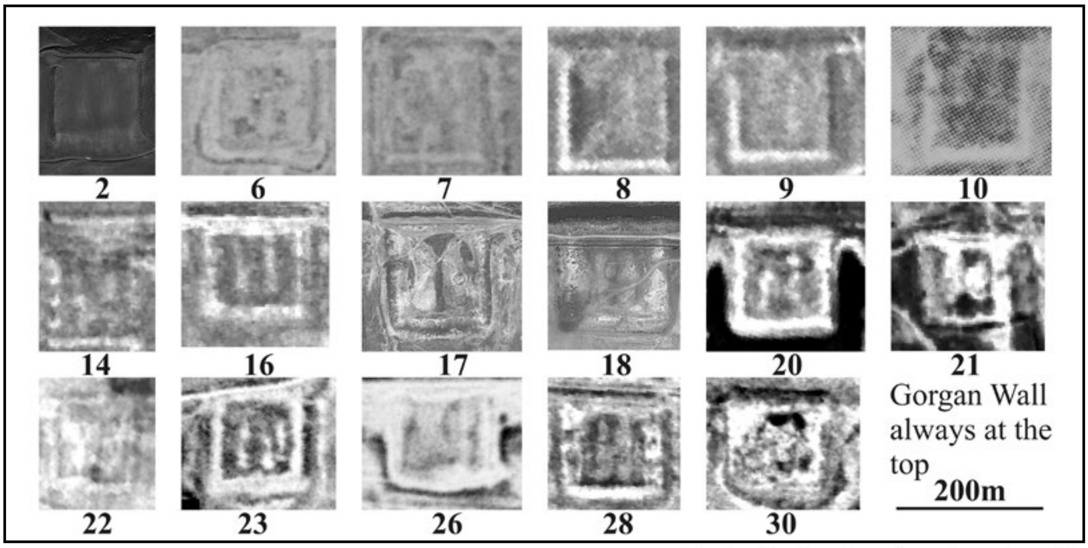
Figure 6.9. Fort 26: possible traces of barracks as visible on Google Earth, Digital Globe, CNES/Astrium (accessed on September 6, 2014).

we see two parallel barracks with ancillary structures added in between or, perhaps, these are robber pits avoiding mudbrick walls. We owe the latter suggestion to Dr Jason Ur and Dr Dan Lawrence, and observations on a subsequent site visit, on November 26, 2014, have added strength to their hypothesis. Today the site is dotted with robber pits (personal observation, JN and EWS). Earth-moving operations in the past might have revealed differences in soil colour, e.g., between mudbrick walls and the occupation debris and sediments accumulating between them, thus enabling targeted pit digging in search of treasure or fertile soil. Notably the eastern barrack is quite clear with rectangular room units of circa 7–8 m west–east by 4–5 m north–south, separated by straight and shallow ridges. Similar patterns can be observed in the west of the fort, even if less clearly. This geometric arrangement is unlikely to be random.

Forts for fixed-size units and their functional design

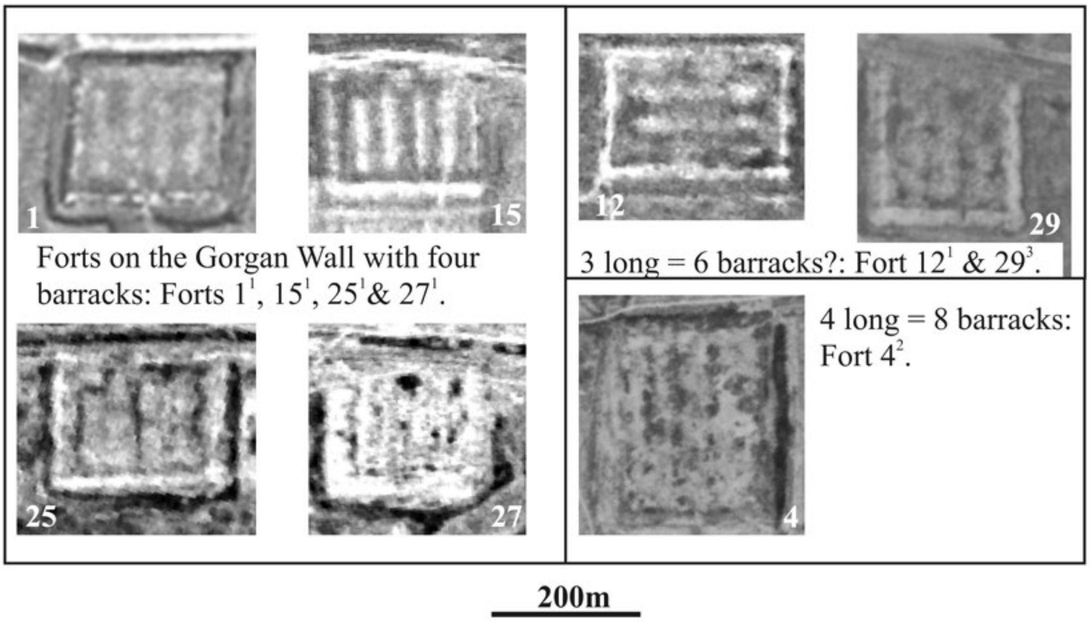
Our research not only enabled us to postulate dense and permanent occupation of the forts and venture an approximate numerical estimate of the possible garrison, we also found probable evidence for systematic organisation. The number of long mounds was far from random. Only even numbers of long mounds appear to occur, with the probable exception of mounds of about twice the average length (of circa 80–120 m), such as three mounds of approximately 180–200 m length in Fort 12, likely to represent double-barracks and thus not invalidating the pattern. Not only was a permanent standing army garrisoning the forts, there were probably army units of fixed size and subdivisions, hence all forts containing an even number of barracks: two, four, six and, once only, eight (Figures 6.10–6.11), with stronger forts often placed at more vulnerable sections of the Wall (Figure 6.13). We may assume that this reflects units of different numerical strength, quite possibly in neat multiples of a basic unit, each requiring two barracks. Admittedly, this is a hypothesis, rather than a fact proven beyond all reasonable doubt. Barracks appear to vary slightly in size, and we cannot be sure that each was designed for precisely the same number of soldiers, not to mention that nominal numerical strength never matches real numbers in any army. Our proposed model for number of occupants (circa 250 per barrack and roughly 30,000 for the Gorgān and Tammisheh Walls, not counting hinterland bases) has been presented in detail before (Sauer *et al.* 2013: 194–199, 230–234, cf: 234–239, 286–287, especially Table 6:8).

It is worth adding that Fort 2A (Figure 6.12) may have been reduced in size through erosion and that Fort 5A (Wilkinson *et al.* 2013: 59–60 with fig. 3:36; cf. Kiani 1982b: fig. 1) should be added as another probable standard-size fort with no barracks visible on satellite images. However, as with all numerical estimates of ancient populations or groups within, there can never



Forts on the Gorgan Wall with two barracks: Forts 2[3], 6[2], 7[2], 8[1], 9[1], 10[4], 14[1], 16[1], 17[3], 18[3], 20[1], 21[1], 22[1], 23[2], 26[2], 28[1], 30[1]. Further forts with possibly two or more barracks (2A and 5) not plotted.
Sources: [1]CORONA 1052 (1969); [2]CORONA 1103 (1968); [3]Google Earth, Digital Globe, CNES/ Astrium; [4]Kiani 1982b: pl. 1.1.

Figure 6.10. The most common forts, with two barracks each: while the smallest category of fort on the Gorgān Wall, their average size (circa 1.5–2 ha) is similar to that of a standard early to high imperial Roman fort for circa 500 men. The two barracks, fewer in number but each of much greater average dimensions than those in Roman forts for units of circa 500 soldiers, could easily have accommodated a garrison of similar size. Tower mounds, clearly visible on the west (left) side of Fort 14, are, in contrast to barracks, normally easier to spot on the ground than from space. CORONA images, courtesy of US Geological Survey; Google Earth, Digital Globe, CNES/Astrium; part of Kiani 1982b: pl. 1.1, reproduced by kind permission of the Eurasia Department of the German Archaeological Institute and Dietrich Reimer Verlag.



Forts on the Gorgan Wall with four barracks: Forts 1[1], 15[1], 25[1] & 27[1].

3 long = 6 barracks?: Fort 12[1] & 29[3].

4 long = 8 barracks: Fort 4[2].

(Gorgan Wall always at the top).
Sources: [1]CORONA 1052 (1969); [2]CORONA 1103 (1968); [3]Kiani 1982b: pl. 2,2.

Figure 6.11. Larger forts, plotted at the same scale as the two-barracks forts. CORONA images, courtesy of US Geological Survey; part of Kiani 1982b: pl. 2.2, reproduced by kind permission of the Eurasia Department of the German Archaeological Institute and Dietrich Reimer Verlag.

Figure 6.12. Forts 2 (right) and 2A (top left), the former with its two barracks, overlooking the deep valley of the Sari Su River (Google Earth, Digital Globe, CNES/ Astrium, accessed on September 7, 2014, image of March 19, 2012)

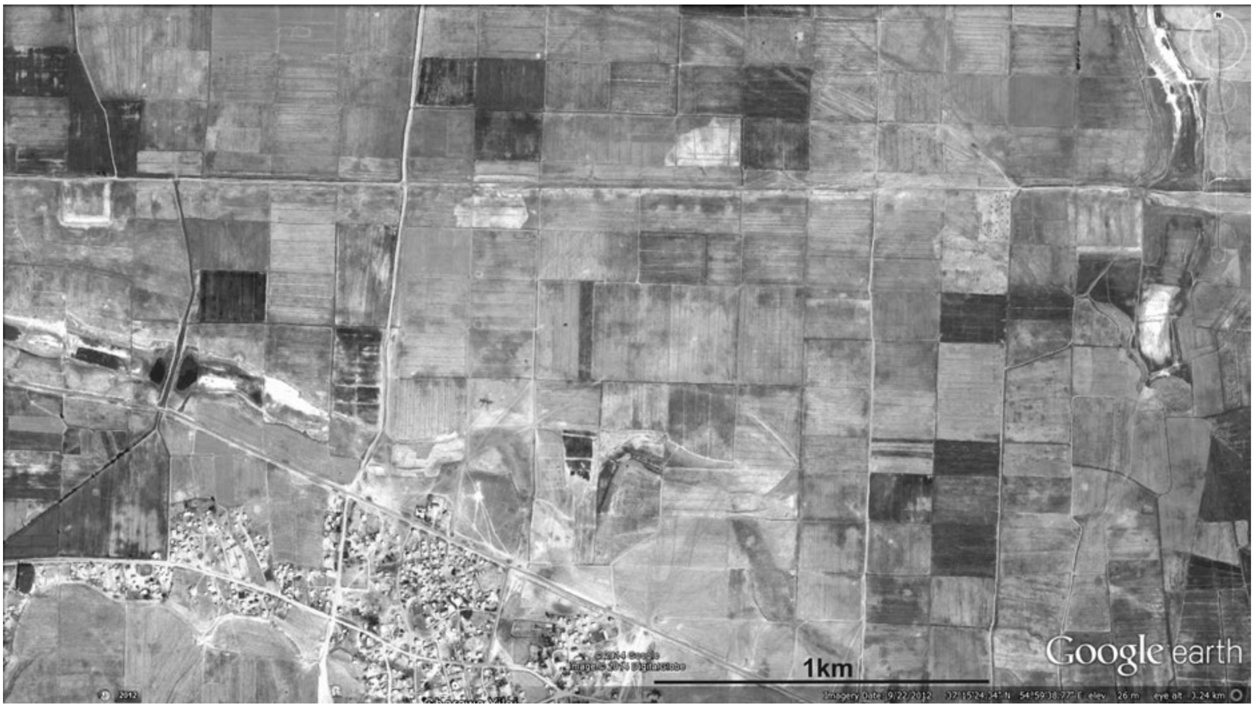


Figure 6.13. Stronger forts are often at more vulnerable points: four-barracks Fort 15 (right) at a stream-crossing; two-barracks Fort 16 (left) at the mid-point between streams crossed by the Gorgān Wall (Google Earth, Digital Globe, CNES/Astrium, accessed on September 6, 2014).

Figure 6.14. Forts 12 (right) and 13 (left), the latter with a reused ancient *tappeh* as a possible look-out post, the former with barracks unusually orientated towards the passage; the unique pair of forts framed perhaps a gate. CORONA satellite image of 1969, courtesy of US Geological Survey.

be exactitude, even if we consider it unlikely that our estimate is several times higher or lower than the real average number.

Unlike their early Roman counterparts, late Roman barracks often lack more spacious officers' quarters. The absence of larger rooms and special accommodation is a trademark of the changed military doctrine of Late Antiquity, rather than being characteristic for one empire more than another. Military compounds were more heavily defended, so as to give them a better chance to withstand a siege. Space was now at a much greater premium, and care was taken to keep the area to be defended as small as possible. Filling forts with a single type of building, for all accommodation and storage needs, while not wasting space on administrative buildings or lavish accommodation for those of higher rank, allowed the maximisation of the ratio between military personnel and intramural space. The simple geometric design, with broad open spaces between straight buildings, also kept obstruction of movement within the fort to a minimum, while at the same time providing outdoor space for food preparation and, probably, tethering horses.

Enabling easy movement within the intramural area indeed seems to have been a high priority for those drawing up the blueprint for Sasanian fort design. Barracks are normally at a right angle to the Gorgān Wall. While orientation of features, e.g., of brick kilns sometimes parallel and sometimes at a right angle to the Wall for unknown reasons (Sauer *et al.* 2013: 143–144), could occasionally just have been based on an ad-hoc-decision, the alignment of barracks is likely to reflect careful planning: the average walking distance from individual rooms to the most vulnerable side, on the Great Wall, would have been less than if the barracks had been parallel to the Great Wall, thus often blocking the most direct route. A quicker response to a surprise attack would have been advantageous, notably at times of poor visibility. Furthermore, it may have saved a small amount of time and effort for any soldiers on garrison duty on the Wall, or any travelling to the hinterland. The parallel alignment of Fort 12's barracks to the Wall, in contrast to most other forts, was probably not fortuitous either. The location of route-ways and the unique positioning of two forts (12 and 13) next to each other (Figure 6.14) and near a major cluster of probably Sasanian installation in the hinterland may potentially suggest that there was a gate in the Wall at this point (Sauer *et al.* 2013: 20, no. 12, 234). Apart from a possible fort on Qizlar Qal'eh (Sauer *et al.* 2013: 227–230), Fort 13 is, interestingly, the only fort on the Wall incorporating a high settlement mound (with the telling name 'Qaravol Tappeh', i.e., the 'guard-post' or 'look-out mound') that might have been

Figure 6.15. Hinterland fort with corner citadel (top right) at Habib Ishan (Schmidt 1940: pl. 67, courtesy of the Oriental Institute of the University of Chicago).

useful as an observation platform. The route across the Wall, rather than the Wall itself, would in this instance have been the centre of attention, and the orientation of the barracks in Fort 12, facilitating fast access to the crossing point, may reflect this. Satellite images of Forts 5 and 2A (Figure 6.12) do not reveal much of any interior structures. The latter is atypical for the Gorgān Wall, in that virtually all its interior is strewn with robber pits in no recognisable geometric arrangement. Perhaps the fort next to a village was targeted by treasure hunters rather than brick robbers, as there is no clear evidence for extensive use of fired brick in the interior of this or other forts on the Gorgān Wall. There are potential traces of strips parallel to the Wall in these two forts, but we cannot be sure whether these are the remnants of barracks, or whether they may reflect some modern land-use pattern. In the former hypothetical case, the orientation may suggest a focus on a vulnerable river crossing. Whatever their interior plan, that there were matching pairs of defensive compounds on the Gorgān Wall, guarding both sides of two river crossings (Figure 6.12), Forts 5 and 5A, 2, and 2A (the latter a later addition which also protected a canal), was first fully recognised by Hamid Omrani and Tony Wilkinson (*et al.* 2013: 59–63; cf. M. Mehryar's map: Kiani 1982b: fig. 1). While any interpretation of the indistinct strips in Forts 2A and 5 has to remain speculative unless, and until, further evidence emerges, there is no question that barracks in the majority of forts were at a right angle to the Wall and that Fort 12 forms an exception.

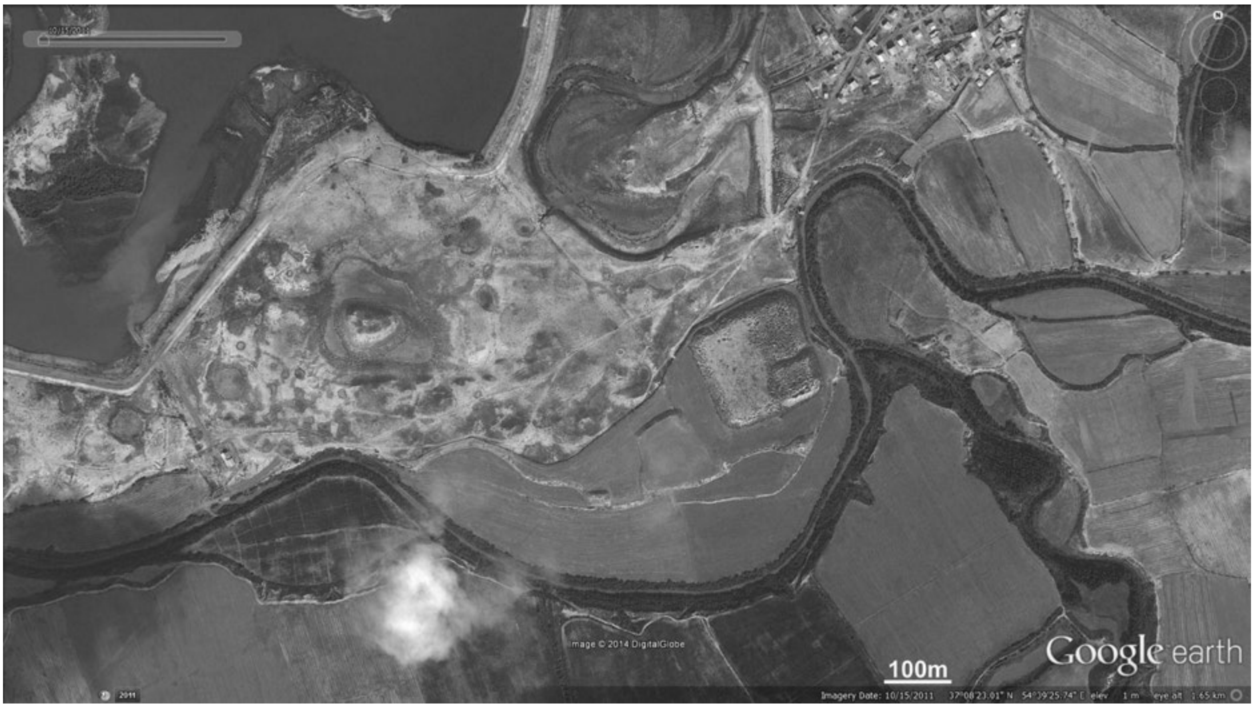


Figure 6.16. The same hinterland fort on Google Earth, Digital Globe, CNES/Astrium (image of October 15, 2011, accessed on September 6, 2014).

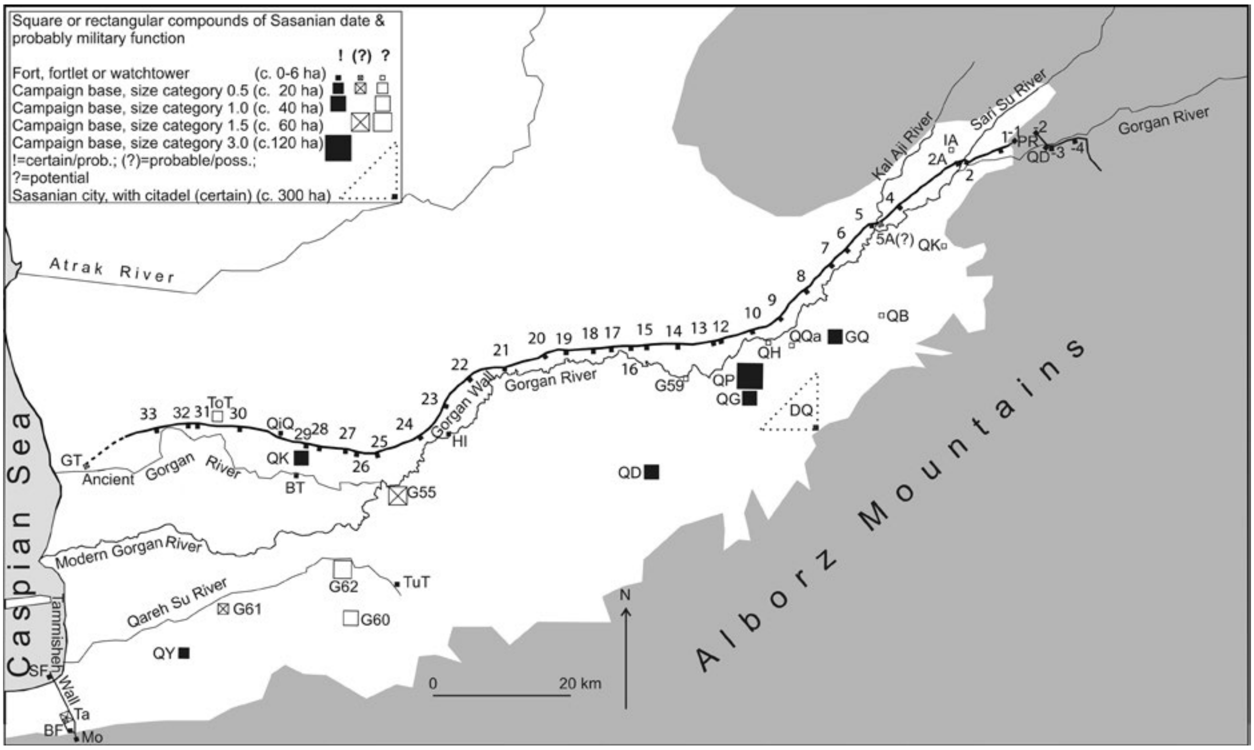


Figure 6.17. Sasanian military sites in the Gorgān Plain.

Forts for garrisons of fluctuating size

Sasanian military compounds in the Gorgān Plain were not all lined up along the Gorgān Wall, but there were also forts and large campaign bases in the hinterland (Figure 6.17). At present, there is little to add to our previous report (Sauer *et al.* 2013: 303–381; Wilkinson *et al.* 2013: 81–93), but one interesting fort should be noted as an additional hinterland installation. Four kilometres south of Fort 23 and 4 km east of Fort 24, we find a square fort of circa 2 ha size with a corner citadel (Kiani 1982b: fig. 6; Figures 6.15–6.17), a feature it has in common with the Sasanian campaign bases and the Sasanian city of Dasht Qal‘eh, all in the hinterland of the Gorgān Wall. This observation and the following suggest that it is contemporary. Like other corner citadels, its defensive ditch separates it from the remainder of the compound — circumstantial evidence for (continued?) use beyond that of the larger compound. Located at the edge of an ancient settlement and modern Habib Ishan, on the Gorgān River at its confluence with the Qareh Su (‘Black Water,’ a common Turkish name for streams in the area), it is quite probably an additional Sasanian fort. Site survey on November 9, 2014 and subsequent examination of the pottery by Emanuele Intagliata (forthcoming) yielded one late Sasanian rim, as well as typical Sasanian fabrics. Corner citadels of hinterland campaign bases, a feature absent from the forts on the Wall, might suggest that the interior was subdivided, the elevated platform reserved for occupants of special status or for special activities. More probably, large geometric fortifications with small citadels in the Gorgān Plain are another physical manifestation of the principle that the area to be defended should be kept as small as possible.

- Forts, fortlets and watchtowers (0–6 ha) on the Gorgān Wall: certain/probable: -4 to -1, 1 to 2, 2A, 4 to 10, 12 to 33; QD = Qareh Doyub; QiQ = Qizlar Qal‘eh (GWS 50); probable/possible: 5A(?) = fort? opposite Fort 5; GT = Gomish Tappeh.
- Forts, fortlets and watchtowers (0–6 ha) on the Tammisheh Wall or within its defensive cordon: certain/probable: BF = Bansaran Fort; Mo = mound/watchtower at southern terminal of the wall; SF = submerged fort in the Caspian Sea; probable/possible: Ta = Tammisheh citadel.
- Forts, fortlets and watchtowers (0–6 ha) in the hinterland or on the approaches to the Gorgān Wall: certain/probable: BT = Buraq Tappeh (GWS-2); HI = Habib Ishan; TuT = Tureng Tappeh; potential: G59 = rectangular enclosure south of GWS-59; IA = Ishan Aqa (GWS-40); QB = Qal‘eh-ye Bibihalimeh citadel; QH = Qal‘eh-ye Ḥajilar (GWS-57); QK = Qal‘eh-ye Kalaleh (GWS-39, not identical with Kiani's synonymous site of more irregular plan: Kiani 1982b: figs 2 and 31); QQa = Qal‘eh-ye Qabrestan (GWS-56).
- Campaign bases or other large fortifications, size category 0.5 (±20 ha): certain/probable: QY = Qal‘eh-ye Yasaqi (GWS-35); probable/possible: Ta = Tammisheh;

G61 = GWS-61; potential: ToT = Tokhmaq Tappeh (GWS-4).

– Campaign bases or other large fortifications, size category 1 (±40 ha): certain probable: GQ = Gabri Qal‘eh (GWS-49); QD = Qal‘eh-ye Daland (GWS 53); QG = Qal‘eh Gug A (GWS-33); QK = Qal‘eh Kharabeh (GWS-1); potential: G60 = GWS-60.

– Campaign bases or other large fortifications, size category 1.5 (±60 ha): probable/possible: G55 = GWS-55; potential: G62 = GWS-62.

– Campaign bases or other large fortifications, size category 3 (±120 ha): certain/probable: QP = Qal‘eh-ye Pol Gonbad (GWS-37).

– Sasanian city, dating certain, non-military, although an urban garrison (in the corner citadel?) is possible (300 ha): DQ = Dasht Qal‘eh.

– PR = Pish Kamar Rocks, steep western foothills of the A‘rab Dagh, serving as a natural barrier, between fortlets -1 and -2 on the Gorgān Wall.

(Map, updated version of Sauer et al. 2013: 305, fig. 12:2, by Kristen Hopper, Eberhard Sauer and Tony Wilkinson, of sites examined by the joint project and Kiani 1982b.)

While the forts on the Wall were designed for permanent units of fairly constant size, the garrisons of bases in the hinterland may have fluctuated greatly. The citadels housed perhaps small stationary garrisons, with much additional space to accommodate mobile forces boosting numbers in times of crisis.

Conclusions: an empire’s military strength and capabilities revealed by satellite search

No Sasanian barracks fort had been even tentatively identified as recently as 20 years ago, and less than 10 years have passed since certain identification. Before, we thought that the Roman army had a virtual monopoly in the ancient and late antique world in its ability to erect forts with barracks of geometric plan. Satellite search, in combination with other archaeological techniques, has dramatically increased our knowledge since. Indeed, it has led to no less than a revolution. Not only is the assumption of a Roman monopoly of providing troops with geometrically designed barracks, now untenable, any notion of western supremacy in military engineering and organisation in Late Antiquity is in serious doubt. In Late Antiquity, Roman military compounds shrank in average size. Purpose-built barracks were found only in a minority of them. Satellite search has now arguably revealed as much, or more, military accommodation on the Gorgān Plain and in Upper Mesopotamia than from the entirety of the late Roman world. Little is known about permanent military compounds elsewhere in the Sasanian Empire. There are just a few exceptions, such as probable forts — mostly smaller than those on the Gorgān Wall and without known interior buildings — south of Bishapur (Ghasemi 2012). Most of the Empire’s standing army will probably remain archaeologically untraceable, as purpose-built barracks forts were confined to marginal land without existing fortified settlements suitable for reuse (Figure 6.1**)**. We are unlikely to see more than the tip of the ‘military iceberg,’ but enough has emerged to reveal the broader picture. Far from relying on a small and disorganised peasant army, the Sasanian Empire appears to have had a professional army of significant size at its disposal (cf. Howard-Johnston 2012), as demonstrated by the infrastructure it has left behind, impressive in scale and functional design. Insofar as the size of defensive compounds and accommodation units within is a reliable yardstick for the number of occupants, there is now no region anywhere in the late antique world with a higher archaeologically attested troop concentration than the Gorgān Plain.

Postscript

In 2015–2016, we excavated a trench across the eastern barrack block in Fort 2, revealing that the original barracks consisted of a double row of rooms of circa 11 m combined width. Subsequenly, two further rows were added in the east and probably also two rows in the west (the walls of the latter less well preserved). Eventually, the building contained probably six rows of rooms, of circa 29 m combined width. Perhaps the narrow two-row buildings in Fort 4, revealed by magnetometer survey, were the original barracks, the multi-row buildings in Fort 26, barracks with annexes. Excavation would be needed to test if the barracks in Fort 4 had no annexes or, more probably and as in Fort 2, annexes with more lightly built (and geophysically undetectable) walls. Aerial photos now prove that there were indeed two barracks in Fort 5.

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Investigating Mobile Pastoralist Landscapes in North East Iran: The Contribution of Remote Sensing

Kristen Hopper and Hamid Omrani Rekavandi

Introduction

The Gorgān Plain, located in the province of Golestan in northeast Iran, encompasses several different environmental zones. Rainfall averages 800 mm per year in the foothills immediately to the north of the Ālborz mountain chain, and decreases significantly to circa 200 mm per year as one moves north into the steppe near the Ātrak River (Khormali and Kehl 2011: 111). The Gorgān River, dissecting the plain from east to west, represents a rough natural boundary between the well-watered primarily agricultural landscape of the southern half of the plain, and the increasingly arid steppe in the north. In the Sasanian Period (AD 224–250) this natural frontier was supplemented by a *c.* 175 km long defensive wall likely built to control trade, facilitate taxation, and deter raids by groups living north of the wall. Field survey and remote sensing of historical and modern satellite imagery carried out by members of the Gorgān Wall Project (Wilkinson *et al.* 2013), along with data from surveys undertaken between the late 19th century and the present day, have identified hundreds of archaeological sites dating from the Neolithic to the Islamic Periods in this region (Abbasi 2011; Arne 1945; de Morgan 1902; Kiani 1982; Schmidt 1940; Shiomi 1976; 1978; Wilkinson *et al.* 2013; see Figures 7.1 and 7.2). Taken together these surveys have demonstrated the intensity of *tappehs* (mounded sites), fortifications, and irrigation works in the southern portion of the plain, while reinforcing the lack of sedentary settlement or

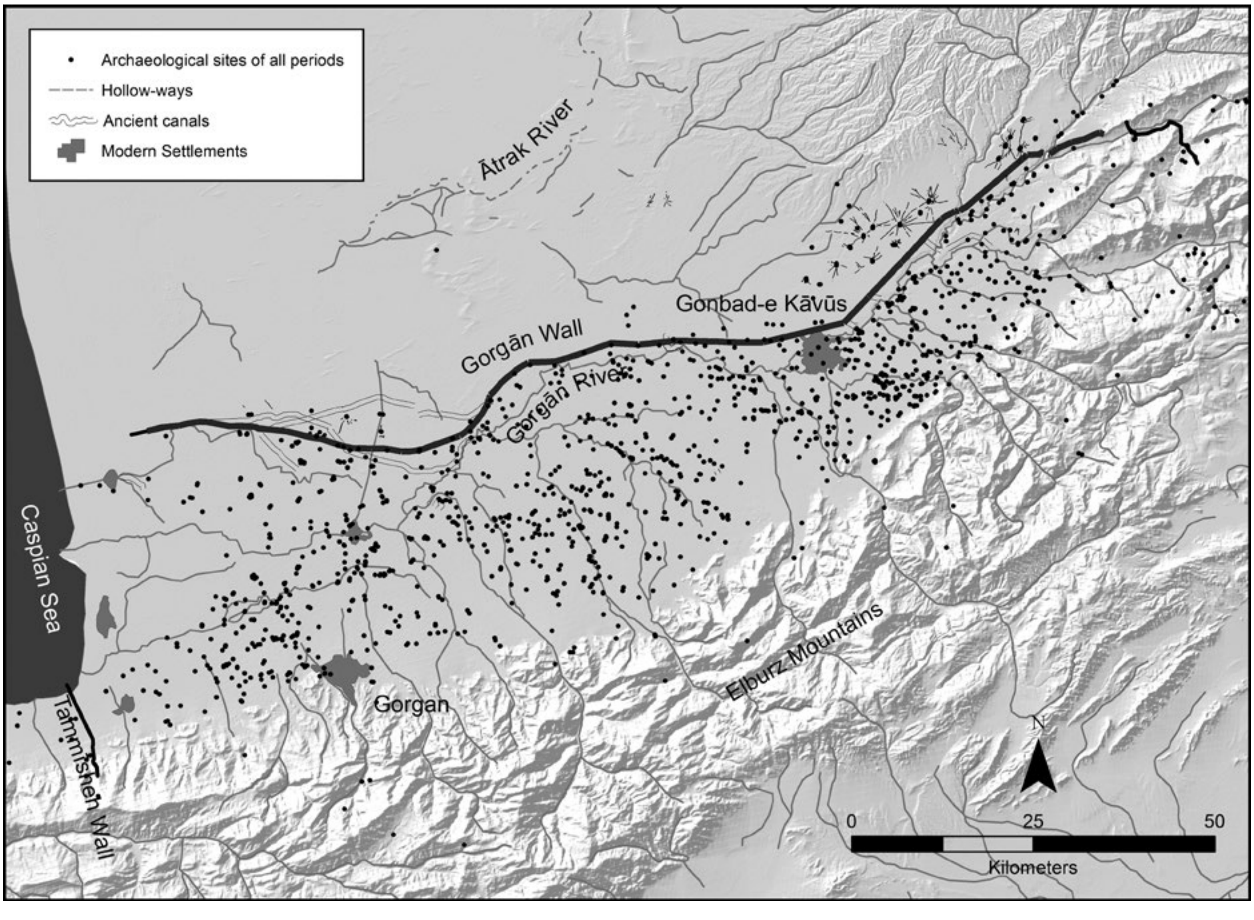

Figure 7.1. Map of Gorgān Plain — distribution of sites, canals, hollow ways, and other archaeological features from all periods in the Gorgān Plain. Note the density of settlement in the southern half of the plain as compared to the northern half. Base map — SRTM 90 m — data available from the US Geological Survey.

New Agendas in Remote Sensing and Landscape Archaeology in the Near East (Archaeopress 2020): 94–108

agricultural investment in the northern portion of the plain in most periods. This pattern is in part due to the intensity of survey to the south of the Gorgān River, as compared to the north. However, the few surveys that have covered the northern portion of the plain, and the remote sensing of the CORONA satellite imagery seem to indicate that it also reflects a real difference in land-use and settlement patterns.

Signature landscapes

Signature landscapes are defined by a package of activities that represent a dominant land-use strategy of a coherent time frame (Wilkinson 2003: 11, 214–215). The dominant signatures in the Gorgān Plain, characterised by dense sedentary occupation and intensive agriculture, are a landscape of tells in the prehistoric periods, and a landscape of dispersal with increasing investment in irrigation systems in the later periods. The former signature is represented by the sheer number and density of Neolithic, Chalcolithic, and Bronze Age *tappehs* recorded by archaeological survey. The latter signature landscape is clearly detectable in the Sasanian Period, and in the more ill-defined Iron III/IV Period in the Gorgān Plain, where absolute and relative dates have established relationships between settlements/fortified sites and massive irrigation systems (Sauer *et al.* 2013). Along with these dominant signatures are the imprints left by land use strategies associated with mobile pastoralism. The traces of these activities are not invisible (for the long running debate on the visibility of nomads in the archaeological record see Cribb 1994: 65–83; Finklestein 1992; Finkelstein and Perevolotsky 1990; Potts 2014: 1–46; Rosen 1992), but depending upon the type of activity and the environment could leave a much lighter imprint on the landscape (Wilkinson 2003: 173). Signature landscapes associated with dense sedentary occupation, agriculture, and irrigation will generally obliterate traces of less robust activity that preceded it.

Mobile pastoral activity is usually easier to detect in more marginal landscapes or landscapes of preservation, such as desert, steppe, or highland, which are naturally too arid to support intensive rain-fed cultivation, but are often exploited for grazing or episodic settlement (Alizadeh and Ur 2007; Wilkinson 2003: 41–43). The traces of such activity are characterised by features such as tent bases, enclosures, and temporary structures, which can be detected by intensive pedestrian survey or, increasingly, through the analysis of high resolution satellite imagery, as demonstrated in the Negev desert, highland areas of Turkey, and the desert fringes in Jordan (Hammer 2012; Kennedy 2014; Rosen 2010: 68). While investigating these landscapes is key to finding direct remains of mobile pastoral activity, it is important to note that we are only viewing the traces of the exploitation of one kind of environment. However, bearing this in mind, landscapes of preservation offer us a view on an important piece of the whole.

The contribution of remote sensing

Aerial photography and satellite imagery are useful for detecting mobile pastoral activity for several reasons. First, we can benefit from an aerial perspective to elucidate patterning and morphology of often ephemeral structures that might be missed in ground-based survey (Kennedy 2011: 1287). Second, we can more quickly investigate landscapes that would take considerable amounts of time to survey utilising traditional methods, or which may be difficult to access. We can also use the results of such exercises to guide field survey. Thirdly, historical images can offer us a perspective on landscapes that may have been altered by modern development. This is particularly significant as traces of mobile pastoral activity are often rather ephemeral and are easily erased by more robust activity. For example, an analysis of CORONA imagery of the Mughan Steppe by Alizadeh and Ur (2007) allowed them to identify Shahsevan mobile pastoralist camps through depressions constructed for corralling animals. The CORONA images had fortuitously caught the landscape at a time when the visible signature was that left by mobile pastoralism. However, while these features were visible in different environmental zones on the historical CORONA, they were not as easily detectable in arable lowland zones during field survey due to modern agriculture.

The archaeological landscape of the southeast Caspian coastline

The usefulness of declassified CORONA spy satellite photography for detecting archaeological sites and features has been demonstrated for landscapes throughout the Near East (Casana and Cothren 2013; Philip *et al.* 2002; Ur 2003; 2013a; 2013b). The CORONA satellite images of the Gorgān Plain taken in the 1960s and 1970s are no exception, with hundreds of archaeological sites and features visible (see Figure 7.2).

Systematic analysis of the CORONA imagery revealed far fewer archaeological sites, from all periods, to the north of the Gorgān River than to the south of it. This is not surprising given the semi-arid nature of the northern plain. This landscape was historically not intensively cultivated and until the mid-20th century had not sustained significant alterations due to modern agriculture. Exploitation of the semi-arid steppe for sedentary settlement and cultivation appears only to have occurred periodically as attested by recent survey and by excavations at Qelich Qoineh. This circa 80 ha site, located to the north of the Gorgān River, has been dated to sometime between the 8th and 5th centuries BC, being occupied for no less than 100, but no more

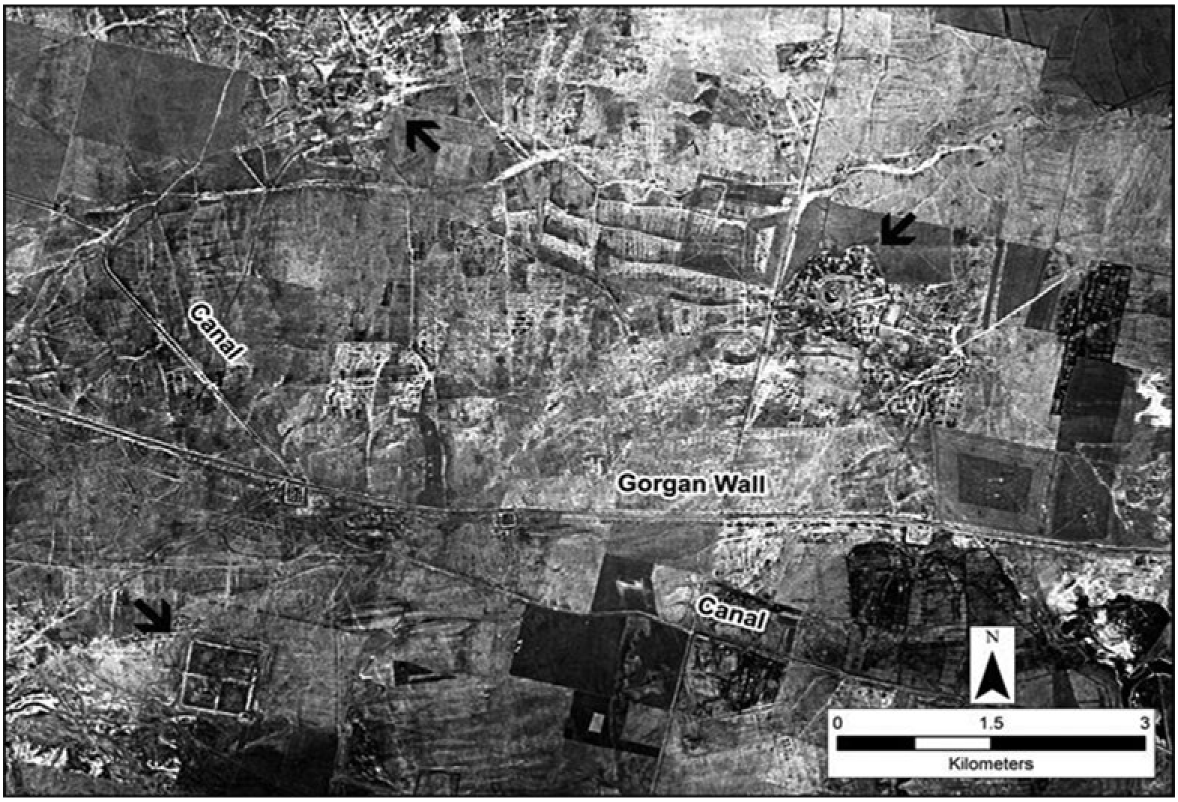

Figure 7.2. Archaeological sites and features on the Gorgān Plain visible on CORONA imagery. Imagery available from the US Geological Survey.

than 300 years. Morphologically similar sites with pottery contemporary to, or slightly later than Qelich Qoineh are common in the steppe, but most appear to have fallen out of use by the Sasanian Period (circa 3rd century AD) (Hopper 2017; Wilkinson *et al.* 2013). However, the traces of activities one might expect from seasonal use of the area in subsequent periods as attested by historical and ethnographic sources, such as animal pens or tent bases, are not visible on the CORONA images.

Imagery from the GAMBIT satellite taken in January 1966, on the other hand, is of higher resolution and of a similar date but due to the nature of the original programme rather limited in coverage. A window of this imagery covering a roughly north–south strip along the Caspian coastline was also analysed and revealed a number of distinct, but ephemeral features either barely visible, or not present on the CORONA imagery, which are possibly associated with less intensive land-use practices.

Remotely sensed features

Features that were mapped on the GAMBIT images have been classified based upon their shape, size, location, relationship to other features, and their 'signature' (or detectable imprint) on the satellite imagery. Some are clearly representative of known landscape features such as canals, qanats, or archaeological sites. Others, mainly a group of circular and sub-circular features, present a new and distinct category. The area over which these features occur is roughly 65 km^2, and approximately 7 km inland from the modern Caspian coastline. The southern end of the cluster is found about 8 km northeast of Gomīshān, and the northernmost limit is located 5.5 km south of the modern Iran-Turkmenistan border.

Feature types

Circular and Sub-circular Enclosures

This category comprises 220 circular, sub-circular, and ovoid features with an internal length between 13 m and 332 m at the widest point. Despite this large size range, their appearance on the satellite imagery, location, and relationship to similar features singles them out as a discrete category.

The morphology of these features is very distinctive (see Figure 7.4). Each roughly circular feature is best described as an enclosure. The perimeter of the feature gives the effect of a raised dashed line, lighter than the surrounding soil. Each of the segments of the 'dashed line' measures between 5 m and 15 m. There appears to

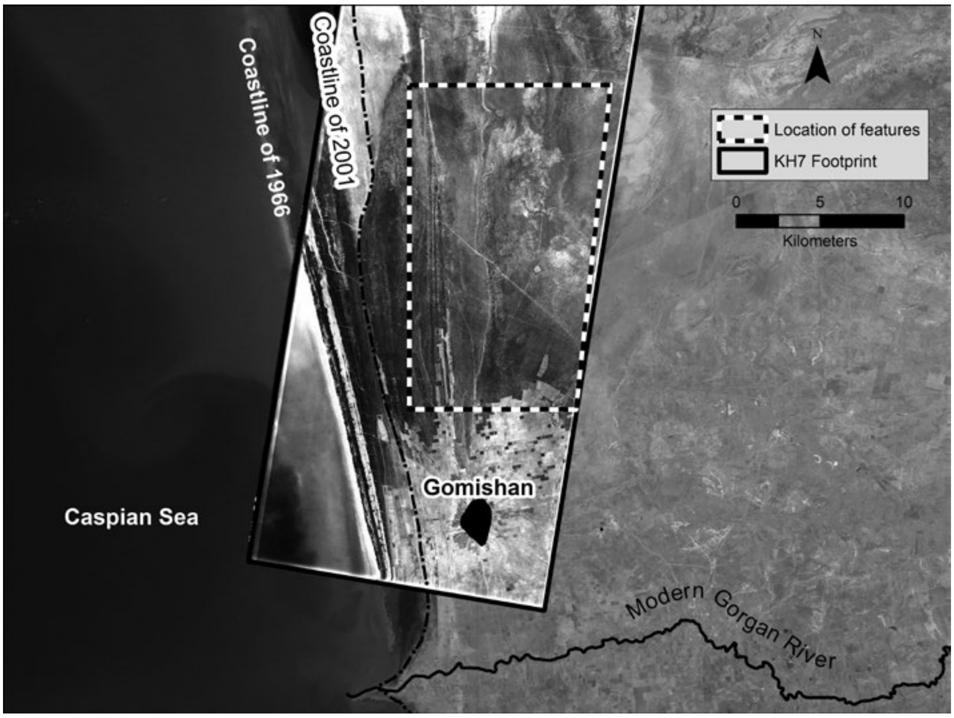

Figure 7.3. Location of circular enclosures and small circular features and coverage of the GAMBIT imagery. Basemap Landsat. Imagery available from the US Geological Survey.

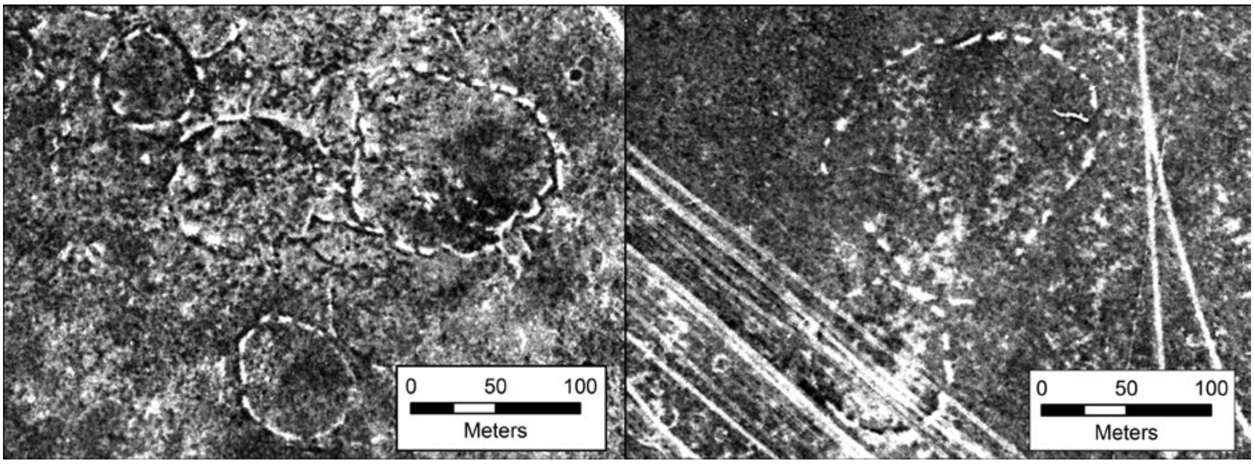

Figure 7.4. Circular and sub-circular enclosures — examples of enclosures visible on the GAMBIT imagery. Note the disturbance of the features in the right image by later tracks. Imagery available from the US Geological Survey.

be no difference in the appearance of the soil inside and outside the 'dashed line', though some of the enclosures appear to have internal features (usually smaller circular features which will be discussed below). Half (50%) of these features fall between 60 m and 120 m in internal length and 95% are between 13 m and 200 m. The average size is 105 m internal length. The graph below (Figure 7.5) illustrates a concentration of feature size between 80–99 m, with the size decreasing rather steadily between 80–13 m, and 100–220 m. There are few features above 200 m.

26% of the circular features are attached to another circle, while internal divisions, and lines of smaller uniform circular features (~5–10 m in diameter) are found in association with 9% of the circular features. Figure 7.5, below, illustrates that there appears to be no distinctive relationship between size or characteristics, and specialised function.

Small circular Features

Small circular features are distinguished from circular and sub-circular enclosures both by their size and their

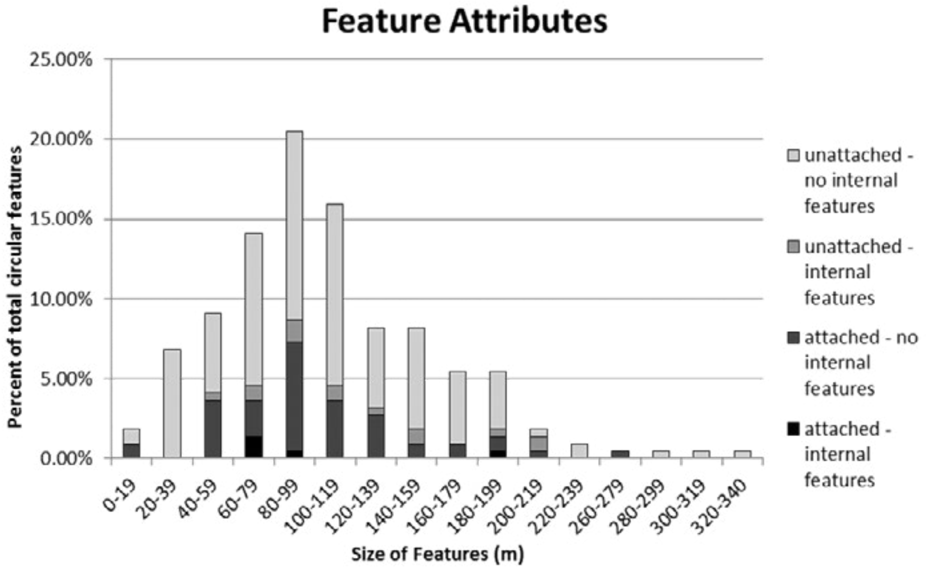

Figure 7.5. Attributes of circular and sub-circular enclosures — this table demonstrates that there is no clear relationship between the size of the features and special attributes such as attachment to other features, internal divisions, and relationships with smaller circular features.

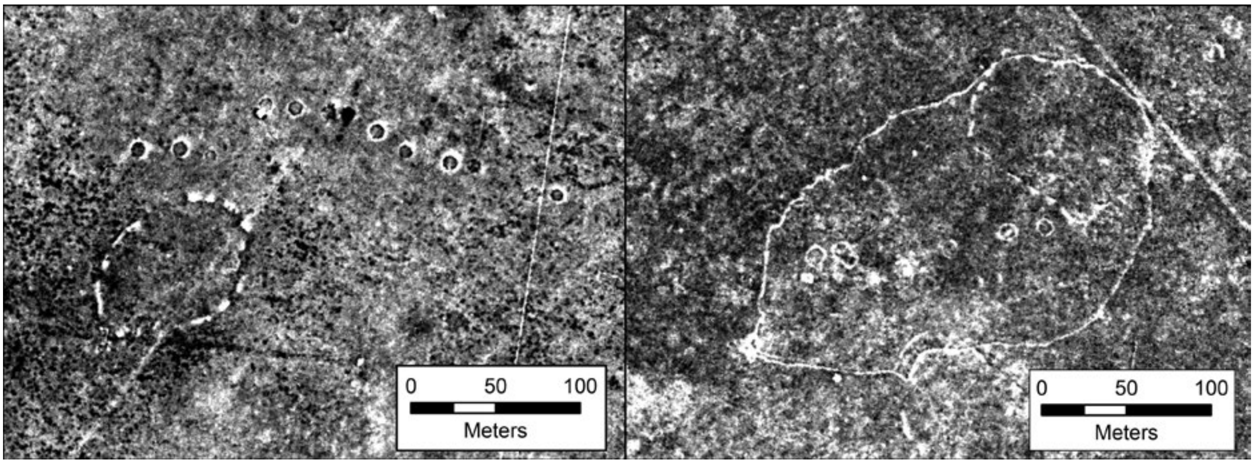

Figure 7.6. Small circular features — these features are generally found in close proximity to the larger circular and sub-circular enclosures and are either found in linear arrangements or clusters of up to fourteen. Imagery available from the US Geological Survey.

signature on the imagery. Smaller (~5–10 m), and more uniform, they generally occur in lines or clusters of two to eight with a few groupings of up to 14. They are located within the same area as the larger circular and sub-circular enclosures. Several clusters occur in the immediate vicinity of the enclosures while others sit within the enclosures (See Figure 7.6).

Several groups exist in lines or clusters along an old shoreline of the Caspian Sea. These are similar in morphology but are much more poorly preserved. The poor preservation of these features can be explained through their relationship with these relict coastlines (see discussion below).

Comparisons of Historical and Modern Imagery

When discussing the location of this feature type it is important to address the issue of visibility. Because the GAMBIT imagery only covers a very limited area, this could affect the perceived distribution of these features. In order to determine if they are in fact limited to this area, other imagery of different resolutions and dates were also viewed to see if the same features were present. This included CORONA imagery from 1968 and 1969, and imagery available on Google Earth from 2013. In total 241 circular features were located. Of these, over half (60%) were only detectable on the GAMBIT imagery, 27% were visible on both the GAMBIT and the imagery used by Google Earth, and 7% were located on all three image types. Small percentages were only located on either the CORONA imagery (<1%) or the imagery on Google Earth (5%).

As the GAMBIT image is of a higher resolution than the CORONA, it is not surprising that while these images are from relatively similar dates (1966 and 1968/1969, respectively) there is a significant difference in the visibility of the circular features. In many cases the circular features that are visible on the CORONA were easy to overlook unless one knew where they were located. The imagery used by Google Earth is also high resolution (circa 0.5 m), but is much more recent. As such, 27% of the circular features are detectable on both the GAMBIT and imagery and imagery on Google Earth. However, the discrepancy in the number of features in this case appears to have less to do with the resolution of the imagery, and more to do with the survival of the features. A significant portion (nearly 50%) of the ovoid/circular features that once existed north east of Gomīshān have been erased due to modern agricultural or building programmes (see Figures 7.8 and 7.9).

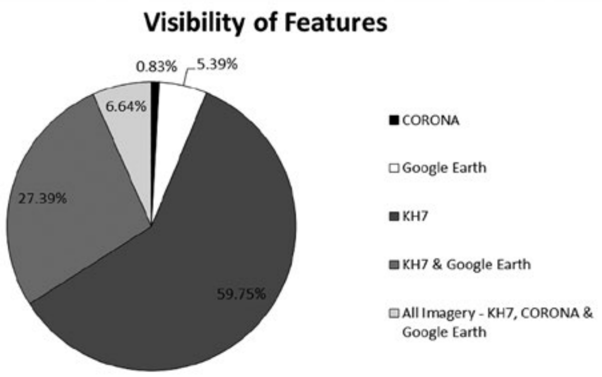

Figure 7.7. Visibility of Features — this graph indicates the percentage of features that are visible on one or more types of imagery with different resolutions and dates.

Despite a lower rate of recovery for the circular features on the imagery on Google Earth, the distribution of those that were detected is significant. The area between the edge of the GAMBIT footprint and an arbitrary line 10 km to the east was examined to determine if these features extended further to the east on the other two imagery types. A further six circular features were located to the east. They were widely dispersed and none was more than 5 km from the edge of the GAMBIT image. It appears that this grouping of circular features does not extend much beyond the limits of the GAMBIT image.

The dynamic sea

Since undertaking this research we have been unable to return to Iran to conduct further field survey. Therefore, other avenues of dating and interpretation have been sought: A hypothesis as to the date and function of these features has been proposed based on their relationship with dated high stands of the Caspian Sea, and historical and ethnographic accounts of land use in this area.

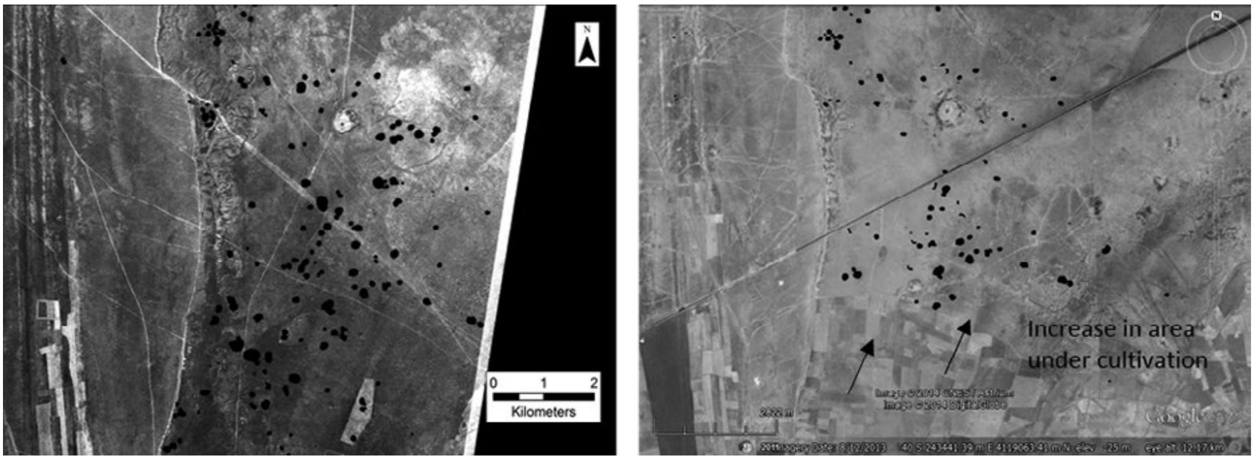

Figure 7.8. Feature distribution on GAMBIT (imagery available from the US Geological Survey) and imagery on Google Earth (© CNES/Astrium and Digital Globe 2014). Note the increase in the area under cultivation in the right hand image from 2013, which has destroyed many of the features that were visible on the left hand image from 1966.

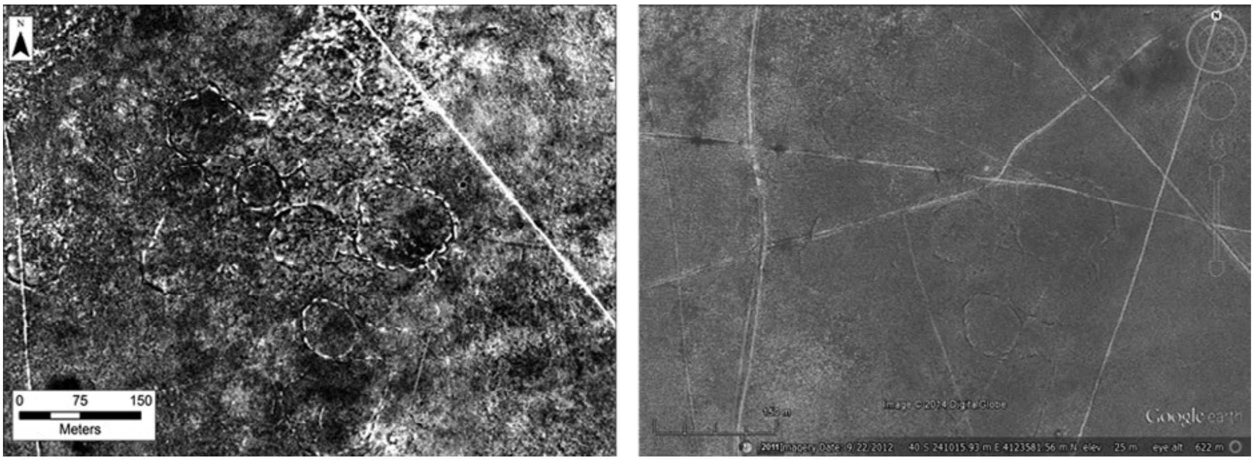

Figure 7.9. Visibility of features on GAMBIT imagery from 1966 (available from the US Geological Survey) and imagery on Google Earth from 2012 (© DigitalGlobe 2014).

Holocene oscillations of the Caspian sea

The study of oscillations in the level of the Caspian throughout the Pleistocene and Holocene has been spurred on by contemporary worries about the environmental impacts of sea level change (Dolukhanov *et al.* 2010; Dumont 1998; Kakroodi *et al.* 2012; Kaplin and Selivanov 1995; Kislov and Toporov 2007; Kroonenberg *et al.* 2007; Lahijani *et al.* 2009; Mamedov 1997; Rychagov 1997). Each of these studies emphasises the incredibly dynamic nature of the sea (which is in fact not a sea, but the world's largest lake), but there is little consensus as to the timings of major transgressions and regressions prior to historical records, with many studies criticised for their sampling strategies and dating techniques, and reliable records on sea level change having only been kept since 1837 (Kakroodi *et al.* 2012; Kroonenberg *et al.* 2007).

A recent review of published evidence for Caspian Sea level oscillations in relation to the archaeology of the region noted the significance of the Derbent regression (covering at least a 1000-year span between 2600 and 300 years BP) on levels during the Sasanian Period (Wilkinson *et al.* 2013: 33–36). A minimum of at least 32 m below sea level (bsl) is attested (Kakroodi *et al.* 2012: 94). This means that during a considerable period of time, which comfortably encompasses Late Antiquity, the sea level would have been significantly lower than at present (circa 27 m bsl). This is supported by the identification of part of the Tammīsheh wall (constructed during the Sasanian Period) located in the Caspian Sea below present sea level (Wilkinson *et al.* 2013: 35).

Taking into consideration a much longer timescale, Kakroodi *et al.* (2012) have recently combined previously published data, with data from new samples taken near the southeast corner of the Caspian Sea to establish an updated sea level curve for the last 10,000 years. This study reinforces interpretations of the Derbent regression, but adds further information on the dating of high sea level stands proposed to have occurred during the Holocene, around 2600 BP, and 280–240 BP obtained through radiocarbon dating of lagoonal deposits (Kroonenberg *et al.* 2007: 140–141). Other research focusing more specifically on the South Caspian coast in Central Guilan — East Mazanderan further suggests high stands at 2500, 900, and 500 BP (Lahijani *et al.* 2009: 67).

Three broad periods of consensus can be drawn from the above mentioned data: 1) a high stand in the 1st millennium BC (Kroonenberg *et al.* 2007; Lahijani *et al.* 2009), the Derbent Regression in which sea levels dropped, generally dated sometime between the 1st millennium BC and the 17th century AD (Kakroodi *et al.* 2012; Karpychev 2001; Kroonenberg *et al.* 2007; Lahijani 2009; Rychagov 1997); 3) an increase in sea levels sometime between the 12th and the 19th century (Karpychev 2001; Lahijani *et al.* 2009; Rychagov 1997).

Actual measurements of the Caspian Sea level began in the mid-1800s and confirm that sea levels oscillated around 26 m below sea level, decreasing slightly between 1900 and 1930, before dipping dramatically between 1930 and the late 1970s, reaching a level of 29.4 m bsl. (Kakroodi *et al.* 2012: fig. 2).

Historical accounts of caspian coastline change

C. E. Yate, travelling through the region in the late 19th century, remarked on the variable nature of the coastline and the traces of ancient monuments (including the Gorgān Wall), both well inland and a considerable distance out to sea:

> 'The marks of this wall for some distance to the east of Gomish Tappa have now vanished, and it is said that they were washed away by the sea, which at one time extended inland ... On the other hand, there was a report that bricks were to be found under the water some distance out in the sea, and that, if true, would seem to show that dry land at one time extended even farther west than it does now' (Yate 1900: 273).

Yate's account clearly illustrates the visible remains of regressions and transgressions of the Caspian prior to the early 20th century. Mustawfi (trans. Lestrange 1902: 741) writes of a sea level rise that engulfed the island of Abaskun, sometime prior to 1340. Abaskun, a port in the south east corner of the Caspian was likely founded under Kavad in the Sasanian Period (Frye 1972: 267), further reinforcing the idea of a sea level rise between Late Antiquity and the 14th century. Other increases in sea level are recorded in the 17th and early 19th century (Dumont 1998: 45). However, as the 19th century progressed there are several accounts of another sea level dip. Muraviev (1871: 16) writing in 1819–20, indicates that while currently a part of the mainland, Gomish Tappeh (in the vicinity of Gomīshān) had been an island up until about ten years before his visit. Sykes (1915: 28–29) further emphasises this by saying that at Chikishlar (modern Chikishlyar, Turkmenistan located circa 60 km north of Gomīshān) 'ships have to lie 3 miles further out than they did 5 years ago.'

Shorelines on historical imagery

Examination of the GAMBIT and CORONA imagery have shown that the farthest inland example of a relict coastline is nearly 13 km from the coastline as it was in 1966. Organic material from a spit of one of these archaic shorelines (circa 10 km from the modern shoreline) was dated during excavations undertaken by the Gorgān Wall Project (Sauer *et al.* 2013). This spit exists near the visible termination of the Gorgān Wall overlying a Sasanian brick kiln (see Figure 7.11). Sauer *et al.* (2013: 152) note that the spit consisted of marine shells overlain by 'c. one metre of weakly bedded mottled clay build up, with thin lenses of pale brown find sand ... These are the types of sediments typically deposited in lagoons, mudflats or a shallow embayment of the sea.' On top of these deposits there is evidence of drying (equated with a regression) and a further thin layer of deposition (equating with another albeit shorter transgression). These shells were dated to between AD 1344–1460 cal. at 95.4% confidence.

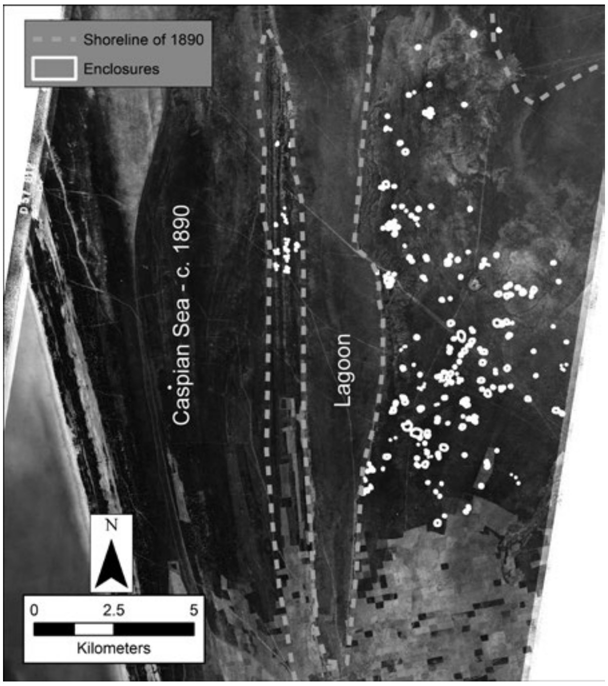

Figure 7.10. Shoreline of circa 1890 in relation to circular enclosures — this image demonstrates the relationship of the enclosures and small circular features with the coastline in 1966 and in 1890. Note that the features appear to respect the coastline of the late 19th century and the limits of the now extinct Hassan Gholi Bay (top right hand of image). Imagery available from the US Geological Survey.

Radiocarbon dates have been obtained from cores for organic material deposited in other transgressions of the Caspian by Kakroodi *et al.* (2012). Several of these, taken at circa 5 km and circa 20 km from the modern shoreline, have revealed dates similar to the material from the brick kiln overlay, further backing up the assertion that sea levels were considerably higher in the 13th–15th centuries than they are today. Kakroodi *et al.* (2012) also compared historical maps with shorelines visible on Landsat and ASTER imagery and reconstructed the location of the shoreline in 1890. European travellers' maps from the 1876–1881 (e.g. Baker 1876; Napier and Ahmed 1876; see Figure 7.11) also suggest a general consensus on the location of the shoreline in the late 19th century.

Discussion

Dating archaeological features by Caspian sea coastline change

Three absolute dates therefore confirm that the shoreline of the Caspian Sea was considerably higher than today at some point during 13th to 15th centuries AD. Furthermore, it reached a point significantly further inland than the features located on the GAMBIT image. Due to the ephemeral nature of the circular

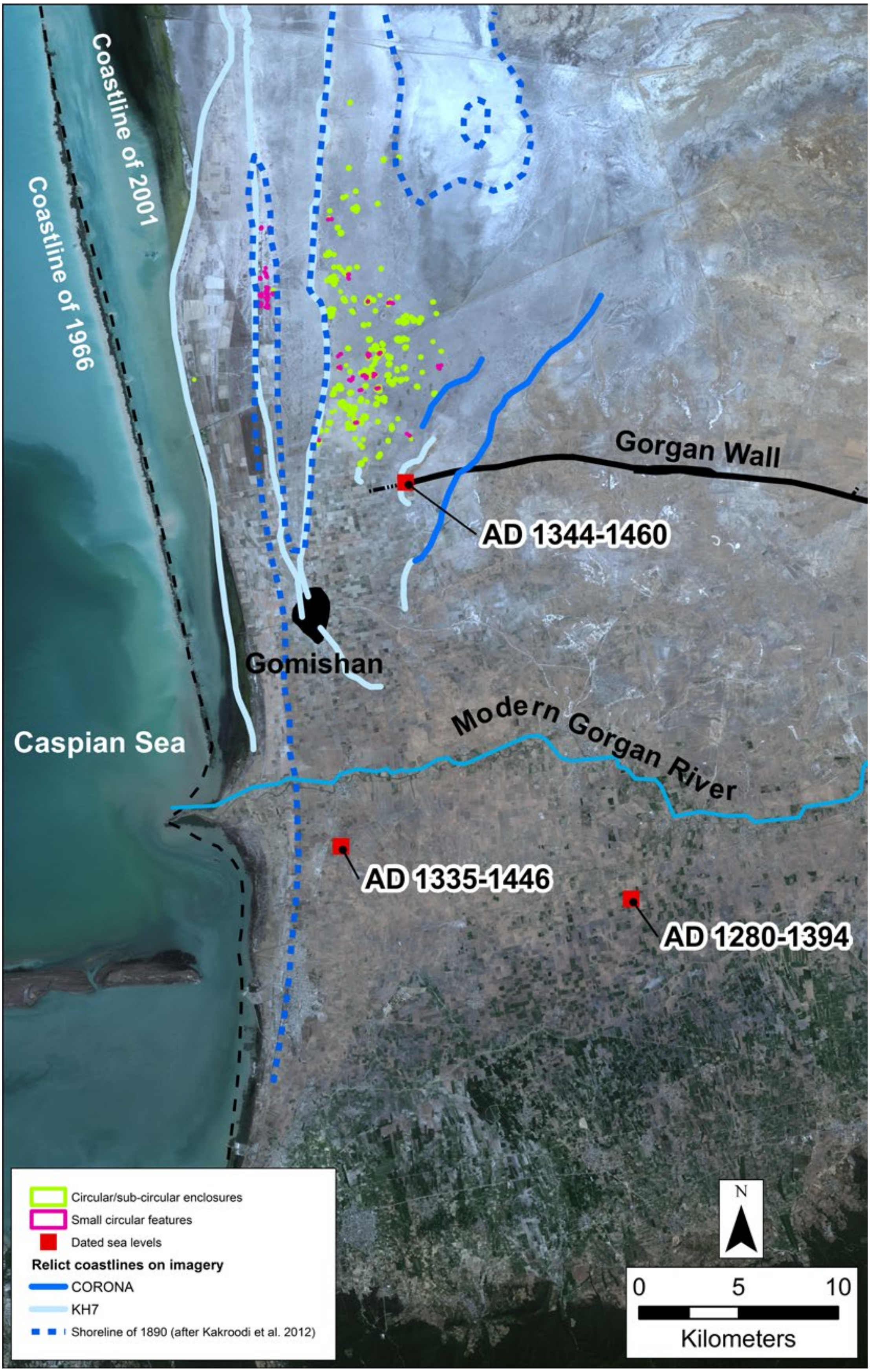

Figure 7.11. Map of the southeast Caspian coastline showing relict coastlines visible on KH7 GAMBIT and CORONA imagery, and dated transgressions/regressions of the Caspian Sea (data from Kakroodi *et al.* 2012; Sauer *et al.* 2013). Base map Landsat-7 from 2001, data available from the US Geological Survey

enclosures and associated features it seems unlikely that they could have been constructed before this date, and survived periods of engulfment by the Caspian. It is therefore likely that they date from after this time.

Two possibilities as to the *terminus ante quem* of these features can also be posited. Firstly, it is possible that they are roughly contemporary with the 19th century coastline, which they appear to respect, including the boundaries of the southern part of the now extinct Hassan Gholi Bay — known to have dried out in the early 20th century (Kakroodi 2012: 96). According to historical data, the sea level appears to have been relatively stable from 1840 or 1850 to the 1920s, roughly at the level indicated on Figure 7.10 and Figure 7.11 (Dumont 1998: 85; Kakroodi *et al.* 2012: fig. 7.2; Muriaviev 1871).

Secondly, these features could also pre-date this coastline. The decreased visibility of the features on the spit of land to the west of the lagoon, and the traces of a succession of relict coastlines on the spit might indicate that these features have been affected by changes in sea level. If this is so then there is a possibility that more of these features could be found underneath the area of the lagoon.

In summary, it would then seem likely that this group of features relate to activity taking place between the 13th and late 19th/early 20th centuries AD. Furthermore, because they appear to be so well preserved on the GAMBIT imagery, it seems likely that they date toward the later end of this range.

Historical land use

Important to the interpretation of the features detected on the imagery is an understanding of historical land use practices in the region. Mobile pastoralism appears to have been an important subsistence strategy in the steppes north of the Gorgān River from at least the late 1st century BC, through the Islamic Period (see Strabo: Falconer 1903; al-Tabari: Bosworth 1989). More recently, ethnographic and historical sources indicate that this area was used for grazing and some dry farming by nomadic and semi-nomadic Turkmen groups (Fraser 1825; Irons 1969; 1971; 1974; Le Strange 1905; Muraviev 1871; Napier and Ahmed 1876; Yate 1900).

Writing in 1825 James Baillie Fraser (1825: 261) notes that from the Caspian sea to the eastern parts of the Gorgān Plain, and from Astrabad in the south to the Ātrak in the north, the area was occupied by one half of the Yomut Turkmen tribe. Muraviev (1871: 9–10), detailing his journey to the southeast Caspian coast in 1819–20, also says that the entire area between the 'White Hill' (located north of Chikishlar and Hassan Gholi Bay) and the 'Silver Hill' (Gomish Tappeh) were inhabited by the Turkmen, who were also engaged in maritime trade in salt and naptha along the Caspian coast. He goes on to describe encampments both on the northern and southeastern banks of Hassan Gholi Bay (Muraviev 1871: 19).

Further historical accounts tell us that alterations of the Ātrak River along the Perso-Russian boundary in the 1880s resulted in the drying up of a southern branch of the river which provided fresh water to the Turkmen inhabiting the southern shore of Hassan Gholi Bay resulting in the abandonment of the area.

> 'There is not a single Persian Yamut now anywhere on the river from Saikh Nazar's little obah near Gudri, where I camped, right down to the sea at Hasan Kuli Bay, and the course of the river having changed, there is nothing to show where the boundary is. The soil along the river is said to be salt and unfit for cultivation, so the land is not of much value except for grazing in summer. In the winter the grazing is best to the north of the river, and the few Persian subjects there have been in the habit of taking their cattle to graze there.' (Yate 1900: 268–269).

Yurts, enclosures, camp organisation, and location

Having established the land-use traditions of the area, it therefore seems likely that these features are associated with the activities of mobile, or semi-mobile, Turkmen groups engaged in herding and small-scale agriculture through seasonal use of this landscape. Likely features associated with this type of activity noted in other parts of the Near East include circular features of varying sizes used for tent bases, huts, corrals, or even burials (Müller-Neuhof 2014; Wilkinson 2003: 174).

The smaller circular features (measuring between 5 m and 10 m in diameter) resemble the signature that might be left by a yurt, the ubiquitous tent used by nomadic groups across Central Asia. The domed tent or yurt-like tent appears to have its roots in Iran and Central Asia, with references in classical sources to the royal tents in the Achaemenid and Parthian Periods, and similar constructions observed by travellers in the 12th and 13th centuries (Wilber 1979: 130; Wright 1958: 158).

The size of a yurt can vary. Wright (1958: 95) indicates that an average tent has a diameter of approximately 5.5 metres. Fraser (1825: 282) echoes these dimensions, with estimates of tents ranging between 15 and 20 feet in diameter (~4–6 m), while O'Donovan (1882: 42) records that yurts are generally 15 feet in diameter and 12 feet high. Ethnographic examples of larger tents erected for special occasions or by richer members of the community have been recorded with diameters of up to 12 m (Wright 1958: 98).

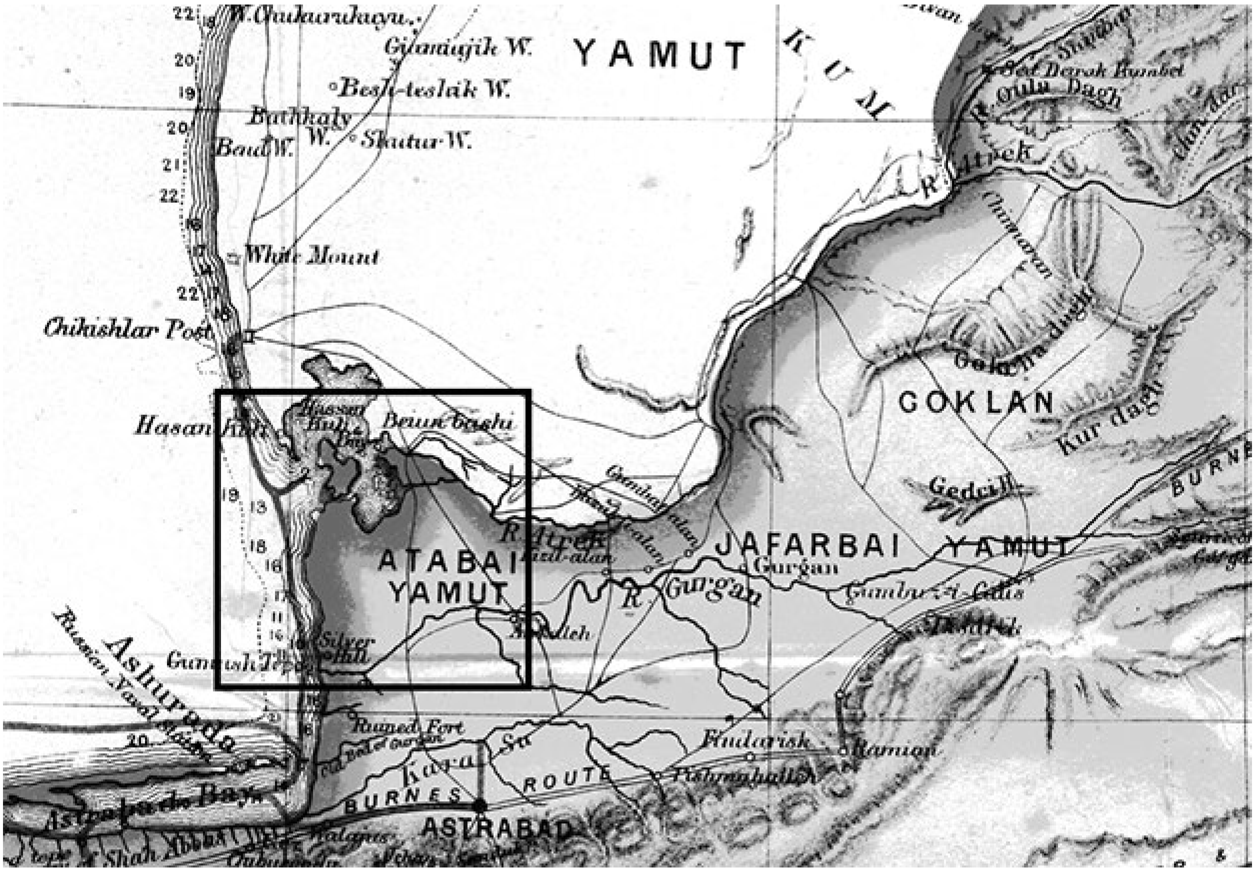

Figure 7.12. Map of Gorgān region after Baker 1876 — the black box indicates the area of interest.

Mud ramparts are said to have been used to insulate and shore up the yurts in winter (Wright 1958: 103). This practice could have left the type of raised bank that can be seen on the satellite imagery.

Wright (1958: 106) describes camps formed of six to eight yurts in a rough east–west line, with their doors generally facing south. These camps form part of a larger group, or *ōba*, which have a shared common territory of up to 20 square miles in the dry season, and 120 square miles in the wet season; when a larger area is utilised for pasture. During the latter season, journeys of up to 10 miles can be accomplished in a day in search of pasture. Camps generally had 50 to 60 tents, but large encampments (numbering 600 to 800 tents) were recorded in the area of Gomīshān in the 19th century (Wright 1958: 106).

Fraser (1825: 283) describes an alternative camp arrangement that consists of yurts, facing towards each other, arranged in a large square creating an enclosed area. Furthermore, 'the more important encampments are often surrounded by a fence of reeds, which serves to protect the flocks from petty thefts'. This description suggests the use of reeds embedded in the earth to construct paddocks or enclosures around a group of yurts to protect flocks. The large circular features on the imagery (with an average diameter of 105 m) may, therefore, represent corrals or pens. The lack of surface stone in the area would necessitate this type of construction.

In late 2014, the location of one of the groupings of large circular features discussed above was visited. Locating the exact anomalies found on the GAMBIT imagery was difficult, however, several modern reed enclosures (or their remains) were found. A discussion with a local Turkmen resident indicated that circular or semi-circular reed structures are used to offer sheep and goats shelter from the wind. The enclosures appear to be made from several shorter lengths of reed fencing. Short sections of reed fence used to construct larger enclosures could be one possible explanation for the dashed-line appearance of the features on the GAMBIT imagery. Currently, only hired shepherds accompany the flocks to the area in the autumn and winter. In the recent past, however, whole Turkmen families camped in the area while grazing their flocks. Furthermore, it was indicated that the flocks were much larger than today, perhaps numbering as many as 500 animals per family grouping. These modern reed structures, while adapted to the modern socio-economic needs of the

Figure 7.13. Photograph of yurt on the Gorgān Plain (Kristen Hopper 2009).

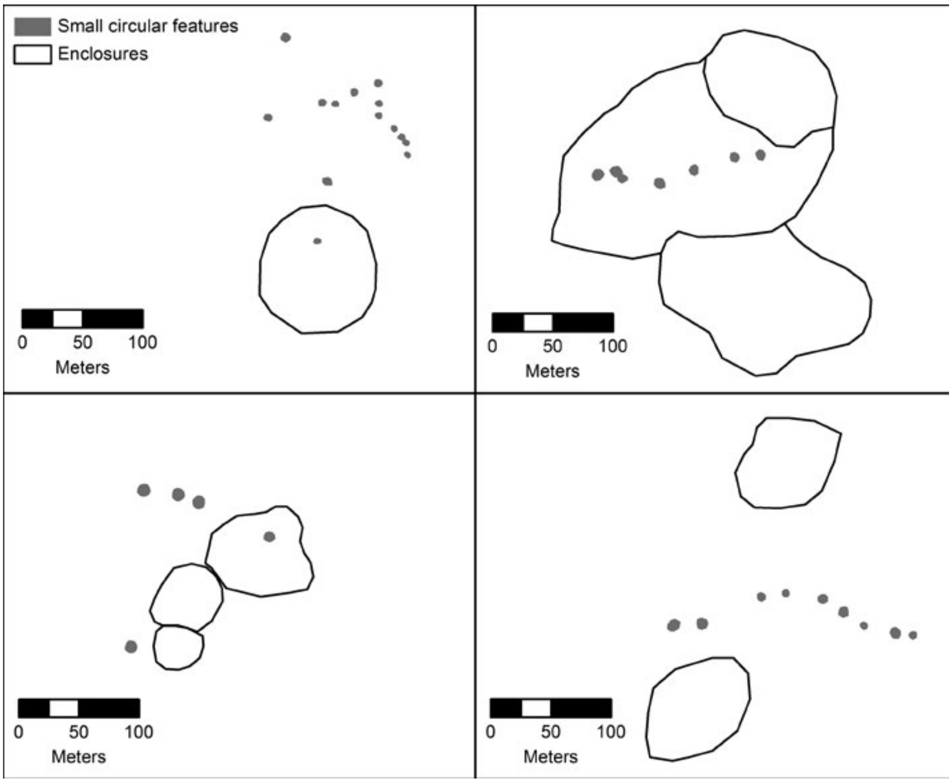

Figure 7.14. Line drawing of circular enclosures and small circular features — the small circular features are usually found in close proximity to the larger enclosures and are either found in a linear or clustered arrangement.

Figure 7.15. Modern reed structures in the area of the remotely sensed features (Andrea Ricci 2014).

Turkmen, demonstrate a long-tradition of structures relating to mobile pastoral activity in the region.

Conclusion

Compared to the wealth of evidence for settlement patterns and land use strategies of agricultural communities in the archaeological record, direct traces of mobile pastoralist activities are scarce. This does not mean that they are altogether absent. Features associated with nomadic, mobile pastoral, and agro-pastoral communities, while likely occurring in a range of environments, are more easily detected in less-agriculturally optimal landscapes or landscapes of survival. In these regions (semi-arid steppe, desert, or highland) the package of features associated with mobile groups such as corrals, tents bases, and circular enclosures etc., make up a distinct landscape signature.

This signature can be found in the northern semi-arid steppe of the Gorgān Plain. In this case, the use of satellite imagery has helped with detecting and mapping a range of features likely associated with pastoral activities. Further field survey of a larger sample of these features is planned and might allow us to confirm or deny these interpretations, however fieldwork in Iran has been difficult in the last few years highlighting the increased importance of remote sensing. Furthermore, the destruction of archaeological sites and features by modern land use and building smes increases the need for the use of historical imagery to look at landscapes that may no longer exist. New ways of dating and interpreting these features also need to be sought. Linking the archaeology with environmental data on Caspian Sea level change and its effect on the local landscape has enabled us to suggest a range of dates for the use of these features (circa 13th–early 20th century AD). Equally, the use of appropriate historical and ethnographic information on land-use practices can help with interpreting the role of these features within their local landscape.

Acknowledgments

This paper stems from work undertaken for the first author’s PhD as part of the *Gorgān Wall Project* and the *Persia and its Neighbours Project* at Durham University under the supervision of Tony Wilkinson. We are grateful for the inspiration and guidance that Tony provided for this and many other aspects of our research. We would also like to extend our thanks to Andrea Ricci for visiting some of the remotely sensed features discussed in this paper.

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The View from the Steppe:
Using Remote Sensing to Investigate the Landscape of 'Kranzhügel' in Its Regional Context

Stefan L. Smith

Introduction

The landscapes of Northern Syria, in which Tony Wilkinson pioneered a wealth of archaeological studies, contain a significant geographical gap of little-to-no investigation. This is the large steppe landscape of the Western Jazira, a region bordered to the east by the Khabur River, to the west by the Balikh, to the south by the Euphrates, and to the north by the southeastern Taurus Mountains — roughly concordant with the Syro-Turkish border (Figure 8.1). At 19,400 km^2, the region encompasses an area twice the size of the Northern Jazira (east of the Khabur), an area with a well-documented wealth of archaeology (Wilkinson, Ur, and Casana 2004: 192–195). While the assumption that the greater aridity and remoteness of the Western Jazira has resulted in a lower concentration of archaeological remains is not entirely without basis, it is as inaccurate to think of its landscape as being largely devoid of sites, as it is to form conclusions of a regional scope based on the long-known corpus of 'Kranzhügel' sites alone (Smith and Wilkinson in press). Since surveys and excavations in the region are, in contrast to the Northern Jazira, limited, it falls to remote sensing techniques to allow the formation of a holistic view of the landscape and its context.

What follows is an overview of the geographical and archaeological landscape of the Western Jazira focusing on the crucial mid-5th to 3rd millennium BC, together with some preliminary interpretations. This period, which saw various urbanisation processes occur in many parts of the Near East (Wilkinson *et al.* 2014), is represented in the Western Jazira by very variable dynamics, with sedentary occupation fluctuating from near-complete abandonment, to its densest ever settlement pattern, and subsequently back to negligible levels (Hole 1997: 46–56; Pruß 2005). It also saw the unique emergence of 'Kranzhügel' settlements — large tell sites with concentric upper and lower towns and prominent encircling fortifications. These dynamics provide excellent data sources with which to interpret and illustrate the driving social, economic, and environmental factors faced by inhabitants of the Western Jazira.

Methodology and prior investigations

The data for this study is based on an intensive, systematic investigation of satellite imagery and digital elevation models (DEMs) carried out across the entire Western Jazira (Figure 8.2). The former largely comprises 1960s-era CORONA satellite photos, which in the nearly two decades since their declassification have been widely used in landscape studies of the Near East, owing to their demonstrated usefulness in mapping both sites and intersite features (Philip et al. 2002: 112–115). These were acquired and georeferenced by members of Durham University's Fragile Crescent Project. The DEMs used are from the JAXA/NASA ASTER device, which is available at a resolution of 15 metres, six times that of extra-US SRTM data (Abrams 2000: 854–858). With the usefulness of DEMs for identifying tell sites in Northern Syria already well documented, potential problematic digital artifact issues pertaining to ASTER (e.g., Menze, Ur, and Sherratt 2006) were circumvented by using it as a backup to CORONA identifications only. Cartographical data, used mostly for determining toponyms, was also obtained, including maps illustrating the travels of early explorer and archaeologist Max von Oppenheim (1911, Tafel 18) and the *Karte von Kleinasien* (Kiepert 1910/1915).

The use of remote sensing naturally introduces a certain degree of uncertainty due to the distanced approach, yet in this instance it is backed up by robust surface control. Such a methodology mitigates issues of subjectivity, such as the visual appearance of sites on aerial imagery to a particular researcher, by introducing detailed data on material remains and morphological features collected and documented on the ground (Lawrence, Bradbury, and Dunford 2012). This stems from three excavations, at Tell Chuera (Meyer [ed.] 2010), Tell Kharab Sayyar (Meyer et al. 2005), and Tell Tawila (Becker et al. 2007),[1] and two ground surveys, the Wadi Hamar Survey (Kudlek 2006;

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[1] A fourth site, Tell Mabtuh Sharqi (Figure 8.2), was excavated between 2001 and 2010 under the direction of Dr. Antoine Souleiman (Gernez and Souleiman 2013). Regrettably, not enough published data is available from this extensive project and thus it unfortunately cannot be used to inform this study.

New Agendas in Remote Sensing and Landscape Archaeology in the Near East (Archaeopress 2020): 109–123

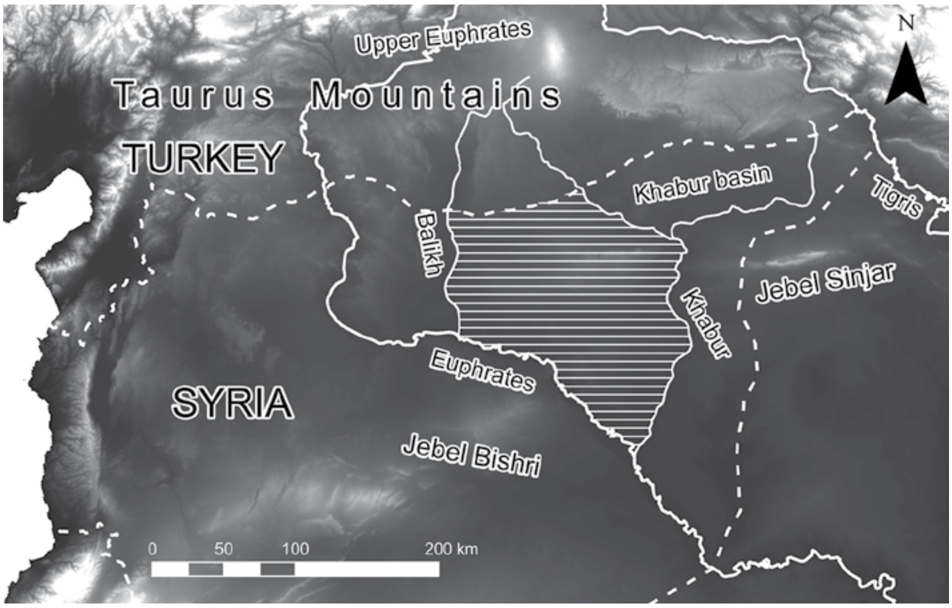

Figure 8.1. ASTER elevation map showing the location of the Western Jazira (horizontal line shading) in its regional context. ASTER GDEM is a product of METI and NASA.

Pruß 2005) and the Yale Khabur Survey around the Jebel Abd al-Aziz mountain (Figure 8.2; Hole 1997: 42–56; Kouchoukos 1998: 365–393). These cover both detailed archaeological knowledge (the result of over half a century of excavations) and a large geographical area — circa 6000 km^2 combined, or nearly a third of the entire Western Jazira. Thus data from these, obtained from numerous published sources, unpublished dissertations and databases, and personal communications, were consistently used as a foundation upon which to build remote sensing-based analyses and interpretations.

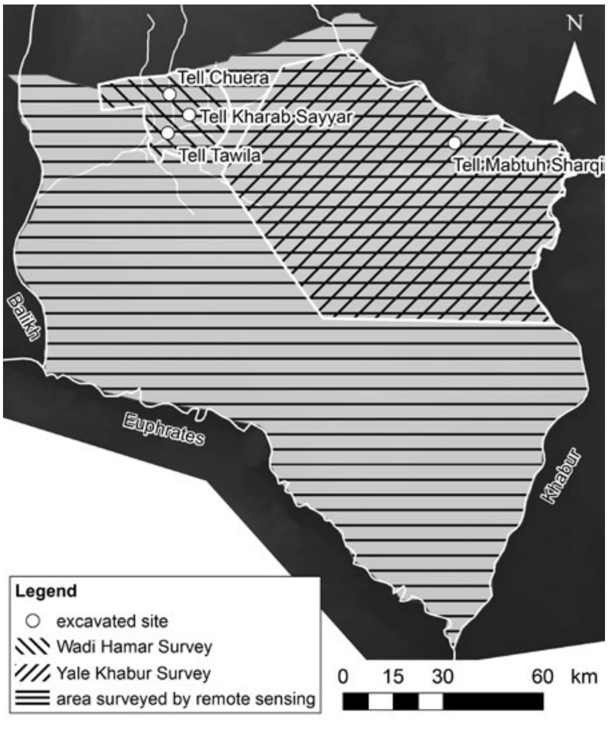

Figure 8.2. Map of the Western Jazira showing surveyed areas and excavated sites.

The landscape of the Western Jazira

The geography of the Western Jazira is largely uniform, the majority comprising a level semi-arid steppe rising between circa 250 and 400 metres above sea level from south to north, respectively. Most of this landscape is used for barley crop agriculture in the present day, much of it dependent on 20th century technology in the form of diesel-powered pumps to raise groundwater to the surface (Hole 1997: 44). However, photographs from the 1910s taken by von Oppenheim (in Moortgat-Correns 1972) show the pre-industrial landscape to have been a homogenous plain dotted with intermittent low-lying shrubs and grasses. This uniformity differs in the southern regions, where lower levels of precipitation form an arid steppe devoid of any vegetation. The landscape is also broken by two major uplands: the Jebel Abd al-Aziz to the east and the Tual ʻAbah to the west (Figure 8.3). The former is an elongated mountain ridge running east–west, measuring 60 km in length and 15 km across, and reaching a height of over 900 metres. The latter is a less clearly defined sprawling upland, measuring some 30 by 30 km, and reaching a maximum height of 640 metres. These areas also see different vegetation, with accounts of the Jebel Abd al-Aziz having been densely covered in a pistachio tree forest

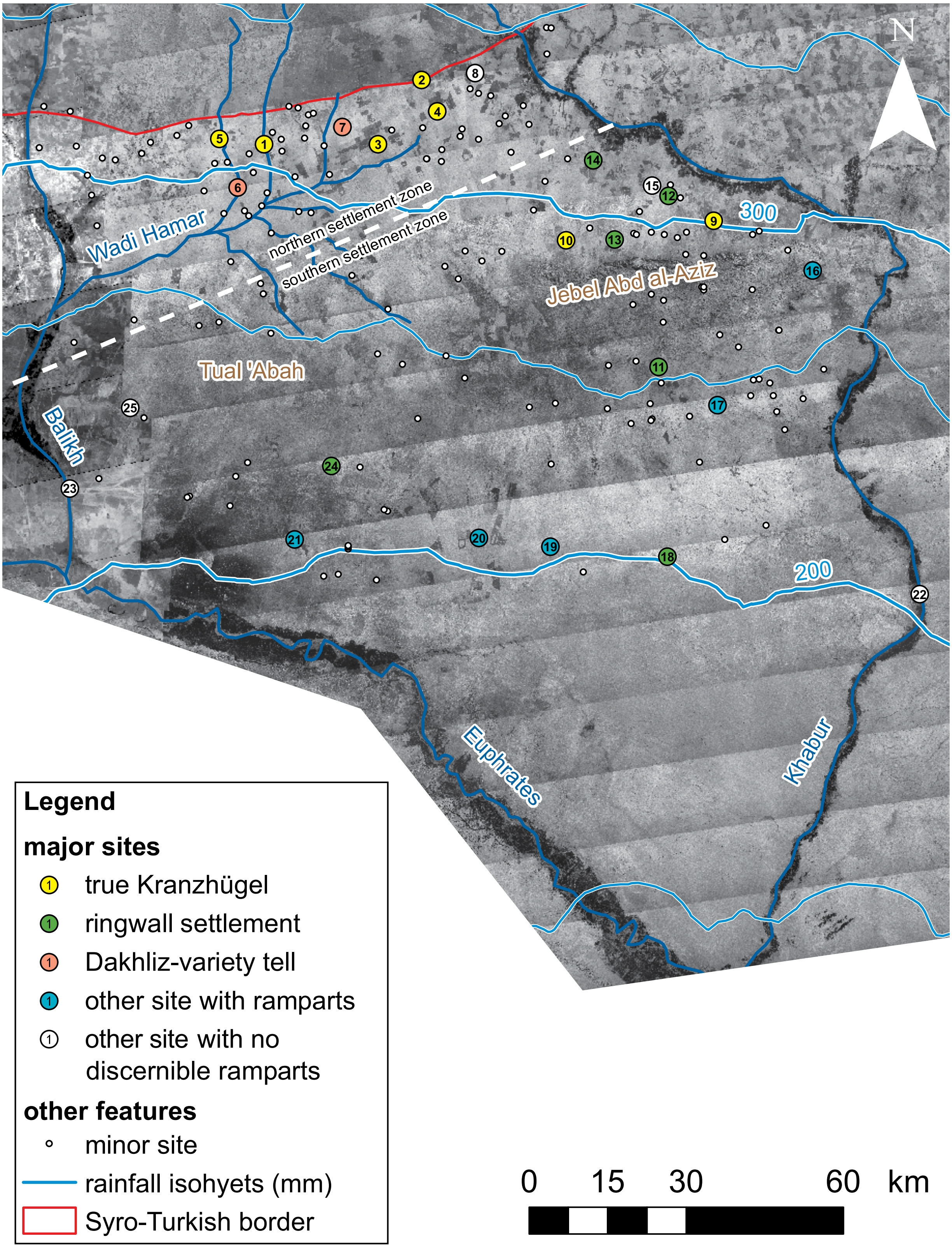

Figure 8.3. CORONA satellite image of the Western Jazira showing major geographical features and all sites of definite or likely EBA occupation, with those mentioned in text labelled. Isohyets are at 50 mm intervals, and represent average annual precipitation from 1980 to 2010 from Global Precipitation Climatology Centre (GPCC) data, processed by Louise Rayne of the University of Leicester. Numbered sites: 1 - Tell Chuera, 2 - Tell Khanzir, 3 - Tell Abu Shakhat, 4 - Tell Bogha, 5 - Tell Ghajar al-Kebir, 6 - Tell Dakhliz, 7 - Tell Glai'a, 8 - Tell Kharab 'Arnan, 9 - Tell Mabtuh Sharqi, 10 - Tell Mabtuh Gharbi, 11 - Tell Mu'azzar, 12 - Tell Hamam Sharqi, 13 - Tell al-Magher, 14 - "Site 34", 15 - Tell Hamam Gharbi, 16 - Tell Barud, 17 - Tell Mityaha, 18 - Khirbet Malhat, 19 - "Site 45", 20 - Tell Zahamak, 21 - Tell Sha'ir, 22 - Tell Asamsani, 23 - Tell Mahlas, 24 - "Site 42", 25 - Bir Sa'id

in the late 19th century (von Oppenheim 1901: 91–92). Regarding the more distant past, palaeobotanical data suggests such woodland to have covered the entire northern half of the Western Jazira until at least the mid-3rd millennium BC (Deckers and Pessin 2011).

The values of average annual rainfall in the Western Jazira vary depending on the data sources used, both for the present day and extrapolated proxies for the palaeoclimate. Some of the most accurate modern data freely available is from the Global Precipitation Climatology Centre (GPCC), of which a subset of averages of mean monthly precipitation totals from 1980 to 2010, processed by Louise Rayne of the University of Leicester, provide the best results (Rayne, pers. comm.). Meanwhile Kalayci (2013: 99–111), extrapolating the speleothem record from the Soreq Cave for Northern Mesopotamia, calculates very different values for both 2800 BC (higher than modern rainfall estimates) and 2200 BC (lower values than the present day), illustrated in Figure 8.4. Such past-present climate discrepancies are a separate discussion not entered into here, but since the GPCC isohyets form a rough average of the two extrapolated Early Bronze Age (EBA) data, and the *relative* correlations between each precipitation dataset and geographical locations remain similar, it was deemed that the modern values can be used to inform a discussion on the region's past environment. Furthermore, with rainfall variations across the Syro-Jordanian steppe fluctuating by at least circa 45% from one year to the next (Sanlaville 2000: 11–12), such stark short-term variations likely had a much greater effect on the region's prehistoric inhabitants than long-term climatic trends.

According to the GPCC data therefore, the highest levels of rainfall occur in the far northeast, which lies around the 350 mm isohyet, while at the southern end the confluence of the Euphrates and Khabur rivers receives a mere 145 mm per annum (Figure 8.3). However, even in the region's wettest areas, high inter-annual precipitation variability causes crop failure to at best still occur one out of every three to six years, precluding the possibility of reliable perennial rain-fed agriculture (Wilkinson and Hritz 2013: 17–18). Between the 180 and 300 mm isohyets, Wilkinson (2000: 3–4) has defined a 'zone of uncertainty' in which agriculture is possible, but at a risk, leading to a dominance of agro-pastoral strategies in contrast to the mobile pastoralism of the arid south.

Rainfall is not the only water source available, however. To the north, the Wadi Hamar is the region's only reliably seasonal watercourse, receiving a consistent springtime flow from the Taurus Mountains of Southern Anatolia (Figure 8.1; Figure 8.3; Kouchoukos 1998: 379–381). Wells for accessing groundwater also contribute to agricultural and settlement potential in the Western Jazira. Much emphasis was placed on the location of these by early explorers of the region, with Alois Musil (1927: 87–89) mentioning ones located near the EBA sites of Khirbet Malhat and Tell Zahamak in the arid south (see Figure 8.3). Both of these are located in low-lying gypsum sinks, where the groundwater table is relatively shallow and thus accessible (Kouchoukos 1998: 386–387). However, the predominant topographic elevation of the Western Jazira does not consistently allow for such easy access.

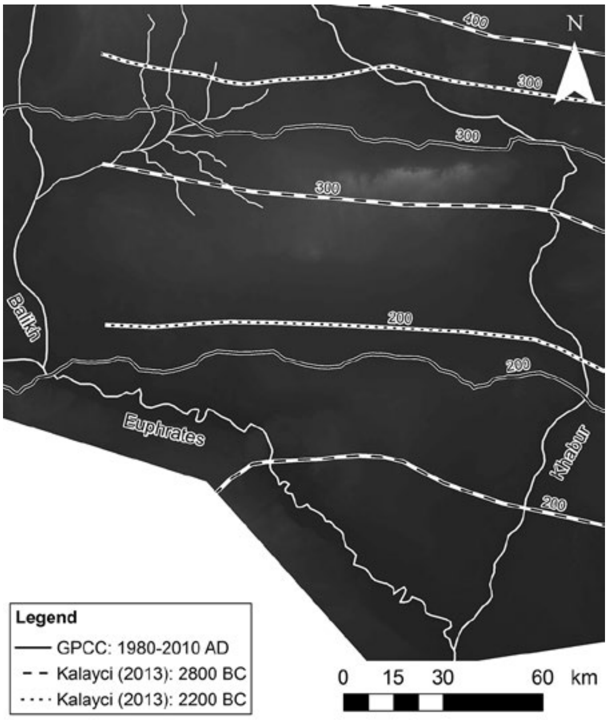

Figure 8.4. Comparative precipitation isohyets across the Western Jazira from a variety of sources. GPCC data processed by Louise Rayne.

Surface runoff from the region's two uplands is a further major contributor to water resources in the southern portion of the landscape, and has been analysed by Kouchoukos (1998: 383–386) along the southern piedmont of the Jebel Abd al-Aziz. In this area, precipitation on the flanks of the mountain collects in shallow seasonal lakes, which in turn charge seasonal wadis, of which at least seven flow southwards. Similar processes likely contribute to the five or more wadis flowing from the Jebel's northern piedmont towards the Khabur (see Kiepert 1910/1915). Additional such watercourses can be found flowing northwards to the Wadi Hamar and southwards to the Euphrates from the Tual 'Abah uplands (see Kouchoukos 1998: Fig. 7.10).

Despite these multiple water sources, settlement sustainability in this region remains a challenge, as all are prone to long and short-term variation. As rainfall values fluctuate, so does the amount of concentrated surface runoff available to charge seasonal watercourses, which can rapidly dry out completely. Meanwhile, the quality of groundwater, and hence the fertility potential of soil nutrients, is also impaired by any consecutive years of drought, severely limiting the possibilities for agriculture (Wilkinson and Hritz 2013: 14–16). Thus all sedentary populations in the Western Jazira would have faced a very uncertain survival potential, leading to erratic long-term settlement trends.

Mid-5th to 3rd millennium BC settlement dynamics

Owing to the remote-sensing basis of this study, all definite chronology data from the Western Jazira stems from the results of prior investigations, presented here in summary. In addition to the excavations and surveys mentioned above, surface collections by the TAVO Survey (Preuss 1989), the Sheikh Hamad Regional Analysis (Kühne and Schneider 1988), and the Khirbet Malhat Survey (Quenet and Sultan 2014) were used to supplement the fairly sparse dating information available. When drawn together, these provide sufficient data to extrapolate across the entire study region.

The Late Chalcolithic (LC) Period of the mid-5th to late 4th millennium BC saw extremely little settlement across the Western Jazira. A total of only six locations with LC occupation (all predating circa 3700 BC) have been identified, representing around 5% of all dateable sites (Figure 8.5). These have been best researched in the Wadi Hamar region, where the excavated sites of Tell Chuera and Tell Tawila contain early LC material, but show evidence of a hiatus of several centuries before their resettlement at the outset of the EBA (Babour in Hempelmann 2013: 35–36; Becker et al. 2007: 260–263). Thus despite there being some evidence for LC sites in the Western Jazira, and a potentially large settlement in the case of Tell Chuera (Helms and Tamm 2014: 287–288), the overall pattern is one of little and intermittent human occupation of the steppe. Though Hempelmann (2013: 271–272) cites palaeoclimatic proxy data (see Weiss 2003) suggesting aridification to have been responsible for the mid- to late-LC abandonment of the region, the specifics of these dynamics are unfortunately too little researched to be able to say anything more concrete on them.

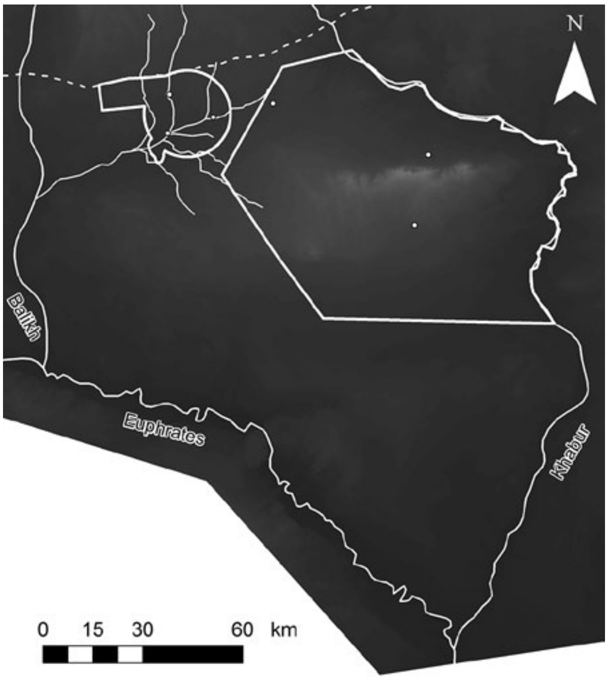

Figure 8.5. Map of the Western Jazira with all sites dated to the Late Chalcolithic marked.

The subsequent EBA could hardly provide a more radically different picture. Not only does the Western Jazira see an explosion of settlement during this period, but a plethora of site types emerge, most prominent among them the large fortified 'Kranzhügel' tells. To quote Hole (1997: 52), 'even today, with industrial scale agriculture and support systems, there are no settlements comparable to those of the third millennium [BC].' Overall, 64 sites were dated to this period, representing 58% of all sites with dateable material (Figure 8.6). Of these, 20 are large (over 10 hectares in size) and 16 are 'Kranzhügel' settlements, though several further examples of this site type exist that have not been dated.

Due to differing chronologies used for various projects, the data available ranges from period subdivisions of between two and six phases. At the more precise end of this spectrum is the Wadi Hamar region and its local TCH I ceramic chronology developed by Winfried Orthmann and Jan-Waalke Meyer, and later refined by a combination of calibrated radiocarbon dates and reconstructions by Hempelmann (2013: 157–161; Table 8.1). This is one of the local chronologies synthesised to form the regional 'Early Jezirah' (EJZ) chronology defined by Lebeau (2011; Table 8.1), part of the ARCANE regional chronology project and employed as a standard for this paper. Thus one can see that the majority of EBA sites around the Wadi Hamar emerged during EJZ 0, and although many were abandoned a mere 400 years later, Tell Chuera and other large sites like Tell Dakhliz (see Figure 8.3) continued to be occupied until EJZ 4a–5 (Figure 8.7; Hempelmann 2013: 187–193; Kudlek 2006).[2]

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[2] The latest EBA radiocarbon date obtained from the Wadi Hamar region is 2465 ±20 cal. BC, corresponding to the start of TCH ID, the penultimate TCH I period (Table 8.1). Thus the dating of the most recent EBA phases is uncertain, leading to a wide range of possible corresponding regional periods (Hempelmann 2013: 184–185).

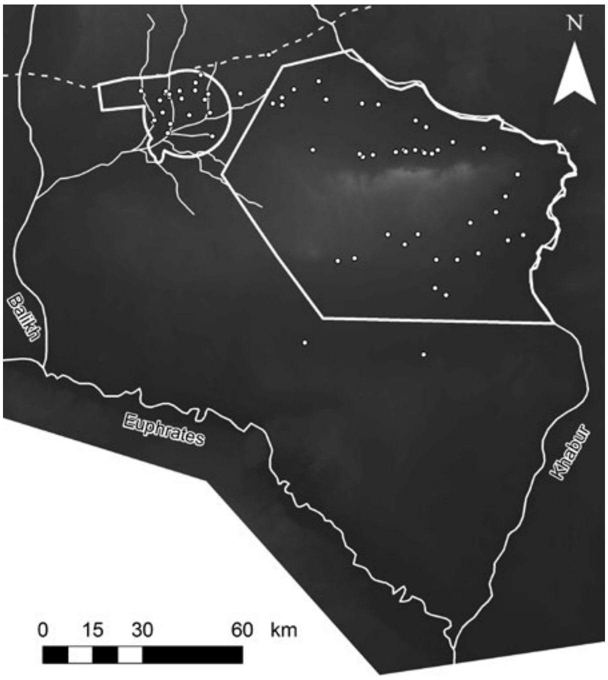


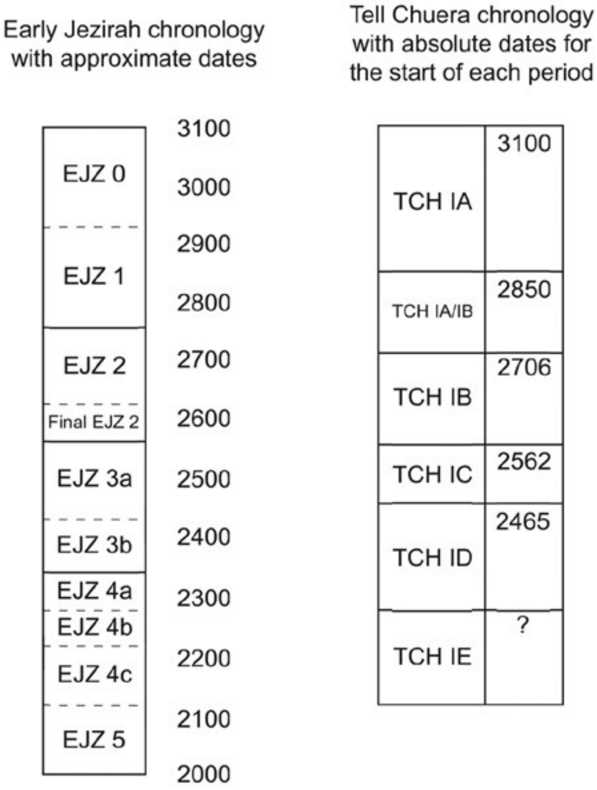
Figure 8.6. Map of the Western Jazira with all sites dated to the Early Bronze Age marked.

The Yale Khabur Survey uses a less precise definition of only two periods: phases I–II and IIIa–IIIb of the first incarnation of the 'Frühgazira' (EJ) chronology developed by Pfälzner (1997). Both this and the EJZ chronology have been correlated with the stratigraphic levels of Tells Leilan, Bderi, and Raqa'i (by Pfälzner 1997 and Quenet 2011, respectively), and by comparing these correlations the EJ sequence can be transposed to the EJZ, providing comparable results (Table 8.2). Thus it can be seen that settlement in the Jebel Abd al-Aziz region commenced a few centuries later than around the Wadi Hamar, during EJZ 1 (Figure 8.7). However, despite being numerous, sites remained small in size until EJZ 3a, when large urban centres emerged (often directly out of the earlier settlements) and remained occupied until the region's near-complete abandonment at the end of EJZ 3b (Kouchoukos 1998: 373).

'Kranzhügel' morphologies

The 'Kranzhügel' variety-of-tell settlement has been documented since von Oppenheim (1901: 86–92) first explored this region in 1899. Although mainly associated with the Western Jazira, this site type exists to the east and west of this region also (Smith and Wilkinson in press). Von Oppenheim defined these as more-or-less circular or polygonal sites with large, low mounds. Furthermore, he emphasised that they are comprised of an inner mound (which he called a 'Burg' or 'Zitadelle') enclosed by bastions or an inner wall, and a lower-level terrace that encircles the former, itself

Table 8.1. Table of dates for the EJZ and TCH chronologies, adapted from Lebeau 2011: 379 and Hempelmann 2013: 161, respectively.



Early Jezirah chronology with approximate dates

Early Jezirah chronology
EJZ 0
EJZ 1
EJZ 2
Final EJZ 2
EJZ 3a
EJZ 3b
EJZ 4a
EJZ 4b
EJZ 4c
EJZ 5

3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000

Tell Chuera chronology with absolute dates for the start of each period

Period	Start
TCH IA	3100
TCH IA/IB	2850
TCH IB	2706
TCH IC	2562
TCH ID	2465
TCH IE	?

Table 8.2. Table of the EJ chronology of Pfälzner (1997: 240) transposed to the EJZ chronology of Lebeau (2011: 379).

Frühgazira EJ chronology (1997 version)	ARCANE EJZ chronology
	EJZ 0
EJ I	EJZ 1
	EJZ 2
EJ II	Final EJZ 2
EJ IIIa	EJZ 3a
EJ IIIb	EJZ 3b
EJ IIIc	EJZ 4a
	EJZ 4b
	EJZ 4c
EJ IV	EJZ 5

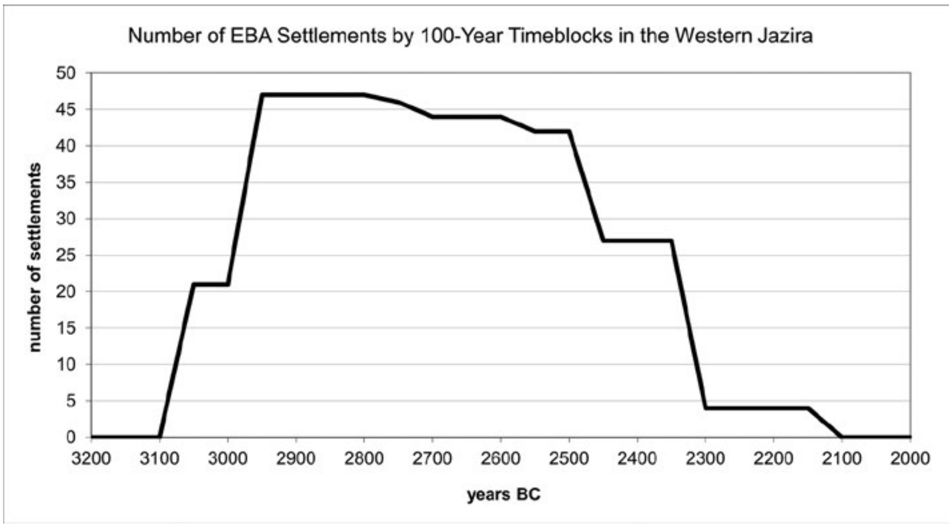


Figure 8.7. Graph of settlement numbers in the two surveyed regions over time during the EBA by 50-year timeblock divisions.

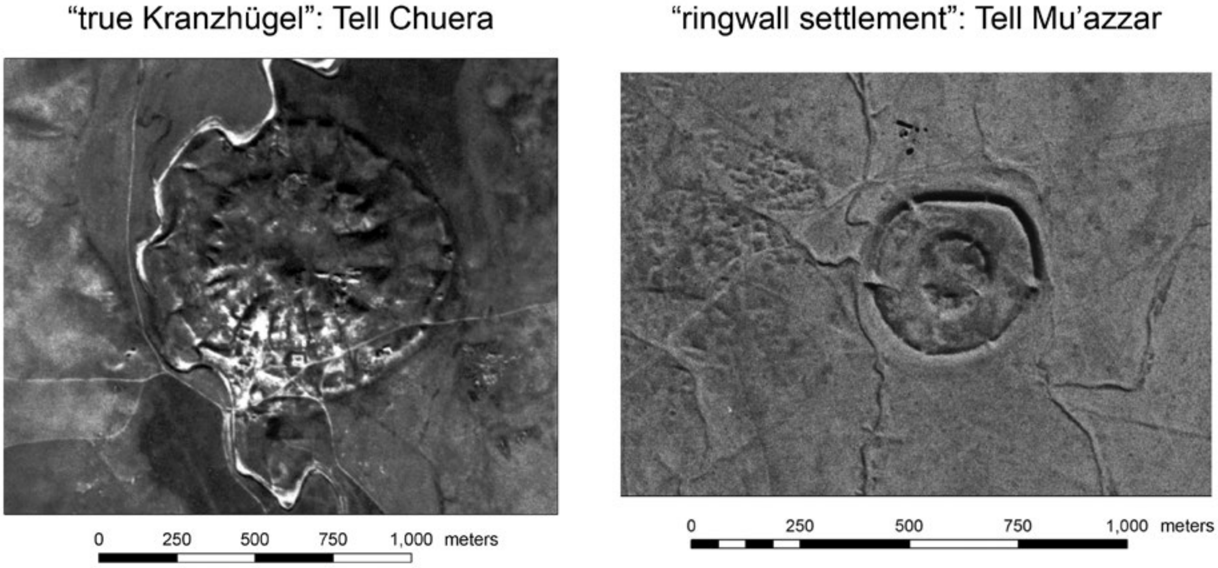


Figure 8.8. CORONA satellite images illustrating the typical difference between "true Kranzhügel" and "ringwall settlements".

enclosed by a further, outer wall (Moortgat-Correns 1972: 26). While this description is broadly accurate for a large number of sites termed 'Kranzhügel' in the Western Jazira, it is both misleading and not universally applicable.

The first problem is the concept that the two concentric walls visible at many of these settlements were in use simultaneously during their entire period of occupation. This is not always explicitly stated but is consistently implied by the widespread use of the term 'double-walled' to describe them. While it is certainly possible that some 'Kranzhügel' sites may have featured a double-walled system from the outset, excavations at the only well-documented example in the Western Jazira, Tell Chuera, showed that this was in fact a gradual process. At the outset of its occupation, this tell was comprised solely of the later 'upper town' and its one encircling wall. Only around four centuries later did the site expand into its lower town and see the construction of the second encircling wall, while the (now) inner wall was refortified, at which point Chuera became truly 'double walled' (Helms 2018).

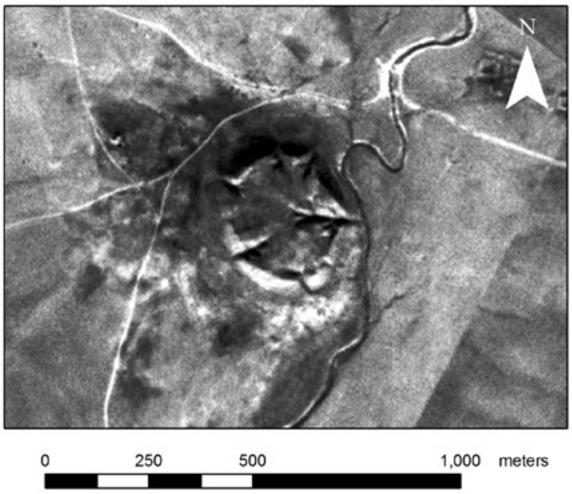


Figure 8.9. CORONA satellite image of Tell Dakhliz.

Secondly, even if the concept of the 'double-walled Kranzhügel' is used purely as a description for the visual appearance of these sites' archaeological footprints, it is inaccurate to homogenously apply it to all large fortified tells in the region. Settlements that have been called 'Kranzhügel' include such diverse sites as Tell Chuera, Khirbet Malhat (Quenet and Sultan 2014), Tell Beydar (Lebeau 1990), Tell al-Rawda (Casana and Herrmann 2010: 74), and Mari (Meyer 2010a). As noted by Creekmore (2008: 342–343), the morphologies of, for example, Tells Chuera and Beydar 'have little in common, and certainly are not more similar to each other than they are to non-Kranzhügel sites.' Evidently, there is a need for clarification and greater precision of the term here.

At least three separate types of 'Kranzhügel' are identifiable in the Western Jazira based on their visual footprints on satellite imagery. Two of these I have previously defined as 'true Kranzhügel' and 'ringwall settlements' (Smith, Wilkinson, and Lawrence 2014: 164–165). The former type resembles Tell Chuera; a circular upper mound with a central depression and a surrounding wall, around which lies a concentric circular lower town on a terrace with its own surrounding wall. Meanwhile ringwall settlements are characterised by a flat-topped circular or polygonal inner mound and barely visible (often seemingly nonexistent) surrounding wall, around which a 'lower town' with hardly any visible structural remains situated on an extremely low (if any) terrace is enclosed by a very clear polygonal outer wall (Figure 8.8). Since defining these classifications, however, it has become clear that further varieties of sites exist that have been indiscriminately labeled 'Kranzhügel.' A third major type I have termed the 'Dakhliz variety' after the eponymous tell site (see Figure 8.3). This is distinguished by an upper town and inner ramparts almost indistinguishable from that of the true Kranzhügel, but a flat concentric lower town with no outer enclosing wall (Figure 8.9).

While the discrepancies between true Kranzhügel and ringwall settlements can be put down to different underlying reasons for their establishment and economic practices of their inhabitants (see discussion below), the Dakhliz variety are perhaps best explained as 'unfinished' true Kranzhügel (Kudlek, pers. comm.). That is to say they each probably underwent the same initial establishment of a simple tell with enclosing ramparts as did Tell Chuera, before expanding similarly also. However, such an expansion was most likely short-lived, or involved activities that were not deemed to require fortification, since it never saw the construction of a further wall enclosing the entire settlement.

Results of the remote sensing survey

As the survey carried out covered the entire region of the Western Jazira (see Figure 8.2), it encompasses both areas incorporated into prior investigations and areas hitherto unstudied. Thus presented here is an overview of the major sites (all marked on Figure 8.3) and offsite features recorded by both others and me from the LC to EBA Periods. These have either been dated on the ground, or have been deemed to very likely date to these periods based on their morphology as seen on remote sensing. Where data on LC–EBA occupation periods is available, this has been listed in brackets; where none exists, the acronym 'ND' (no date) has been used. Also included are the size of each site as measured on satellite imagery, and its ID number from this study's database.

Sites — Wadi Hamar region

This northern region sees a concentration of numerous prominent EBA settlements, many of them belonging to the 'Kranzhügel' variety. The most notable of these is Tell Chuera (Site 22; 68 ha; LC, EJZ 0–4c/5), not only the best-investigated and published site in the Western Jazira, but also its largest EBA settlement. This tell, which defines the true Kranzhügel type, consists of a flat circular central mound with a clear large central depression, while its inner surrounding wall is only faintly visible (see Figure 8.8). Around this extends Tell Chuera's lower town, which is surrounded by a largely circular outer wall that is very clearly visible on all satellite imagery and interspersed by a large number of gaps, some confirmed to be city gates. Several of these appear to align with features in the upper town, indicating the radial street network confirmed by excavations and geomagnetic prospection (Meyer 2010b).

Several other tells in the Wadi Hamar region display a very similar morphology; in order of size, these true

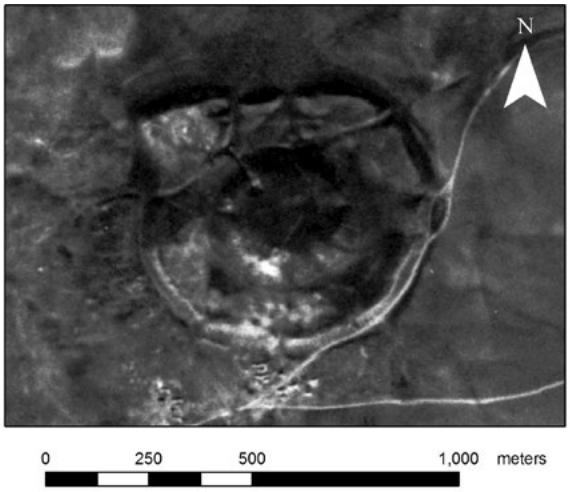


Figure 8.10. CORONA satellite image of Tell Khanzir.

Kranzhügel are Tells Khanzir (Site 27; 40 ha; at least EJZ 3b–5), Abu Shakhat (Site 24; 31 ha; at least EJZ 2–3b), Bogha (Site 25; 22 ha; ND) and Ghajar al-Kebir (Site 21; 20 ha; 'EBA'). Naturally not all these settlements are identical in form; the outer wall of Tell Khanzir, for example, features a protruding angular outcrop on its northwestern side (Figure 8.10). However, they all contain enough similarities in terms of morphology, form, and location to categorise them together.

Two further fortified tells in the Wadi Hamar region have a distinctly different morphology. These are the Dakhliz variety sites of Tell Dakhliz (Site 72; 23 ha; EJZ 0–4a) and Tell Glai'a (Site 116; 18 ha; ND). The former (Figure 8.9) consists of an oval 10-hectare truncated conical tell at its centre, with a flat (not depressed) middle. Its perimeter features a distinct encircling wall, gaps in which could indicate gates. This is surrounded by a clear 'halo' of undulating surface on CORONA imagery, indicating intensive human activity; i.e., a lower town without an enclosing wall. Tell Glai'a is very similar, though more regularly circular and with fewer gaps in its wall. One final large site, Tell Kharab 'Arnan (Site 28; 9 ha; ND) features no visible integral ramparts; though as it is partially covered by a more recent settlement likely dating to the Late Antiquity and surrounded by a clear wall of presumably this period also, the presence of EBA fortifications cannot be categorically discounted.

Sites — Jebel Abd al-Aziz region

The regions north and south of this mountain range also contain a great number of significant settlements. The largest are two true Kranzhügel very similar to those discussed above, located within five kilometres of the northern flanks of the *jebel*; Tells Mabtuh Sharqi (Site 36; 44 ha; EJZ 2–5) and Mabtuh Gharbi (Site 39; 28 ha; EJZ 1–3b). Apart from these, most major settlements in this area are of the ringwall settlement type, the clearest example being Tell Mu'azzar (Site 41; 14 ha; EJZ 1–3b/5), three kilometres south of the mountain's southern piedmont. This site has a circular central mound that is flat on top with a very slight depression, around which a wall featuring several gaps is vaguely noticeable (see Figure 8.8). The surrounding 'lower town' area appears largely empty, with only a slightly undulating surface noticeable on the western side on CORONA imagery. Beyond this, the clarity of the rounded pentagonal outer wall is particularly striking, as are five gaps in it, two of which align with those on the central mound to form a rough northwest–southeast axis.

Three other prominent sites in the area north of the *jebel* exhibit very similar features: Tell Hamam Sharqi (Site 35; 16 ha; EJZ 3a–3b), Tell al-Magher (Site 38; 13 ha; EJZ 1–3b), and Site 34 (4.5 ha; EJZ 3a–3b). A fourth large site, Tell Hamam Gharbi (Site 474; 10 ha; EJZ 1–3b), is a prominent circular tell with a clear central depression, but shows no obvious signs of 'Kranzhügel'-like ramparts. Finally, some small fortified tells such as Barud (Site 481; 2.9 ha; EJZ 3a–3b) and Mityaha (Site 487; 2.5 ha; EJZ 1–3b) are located south and east of the *jebel*; however, these cannot be categorised by the same site typology as the large settlements.

Sites — southern region

The arid steppe south of the Western Jazira's two uplands features a few further major sites, some of which could be called 'Kranzhügel.' These include Khirbet Malhat (Site 46; 33 ha; EJZ 1–3b), situated 40 kilometres south of the Jebel Abd al-Aziz in the most arid location for any large site in the region. The appearance of this clear rounded hexagonal ringwall settlement in a landscape which today receives only 200 mm of rainfall per year (and even at times of increased precipitation in the past likely received less than 250 mm; see Figure 8.4) has long been regarded as an anomaly. However, this study has shown it to be the easternmost settlement on an alignment of sites that stretches between the Khabur and Balikh rivers, skirting the southern limit of accessible water sources. The other major sites along this line, from east to west, are Site 45 (8.6 ha; ND), Tell Zahamak (Site 44; 10 ha, possibly up to 50 ha; 'EBA'), and Tell Sha'ir (Site 43; 21 ha; ND). These appear most similar to the Dakhliz-variety tells, but with enough variations in terms of form and morphology to render them unique (Figure 8.11). They furthermore align with the large potential river-fording sites of Tell Asamsani (Site 1232; 10 ha; '3rd millennium BC') on the Khabur, and Tell Mahlas (Site 16; 6.2 ha; 'early–late EBA') on the Balikh, a site with mid–late EBA fortifications (Curvers 1991: 183–184). Other minor tells ranging from 0.4 to 1.6 ha also lie along this line.

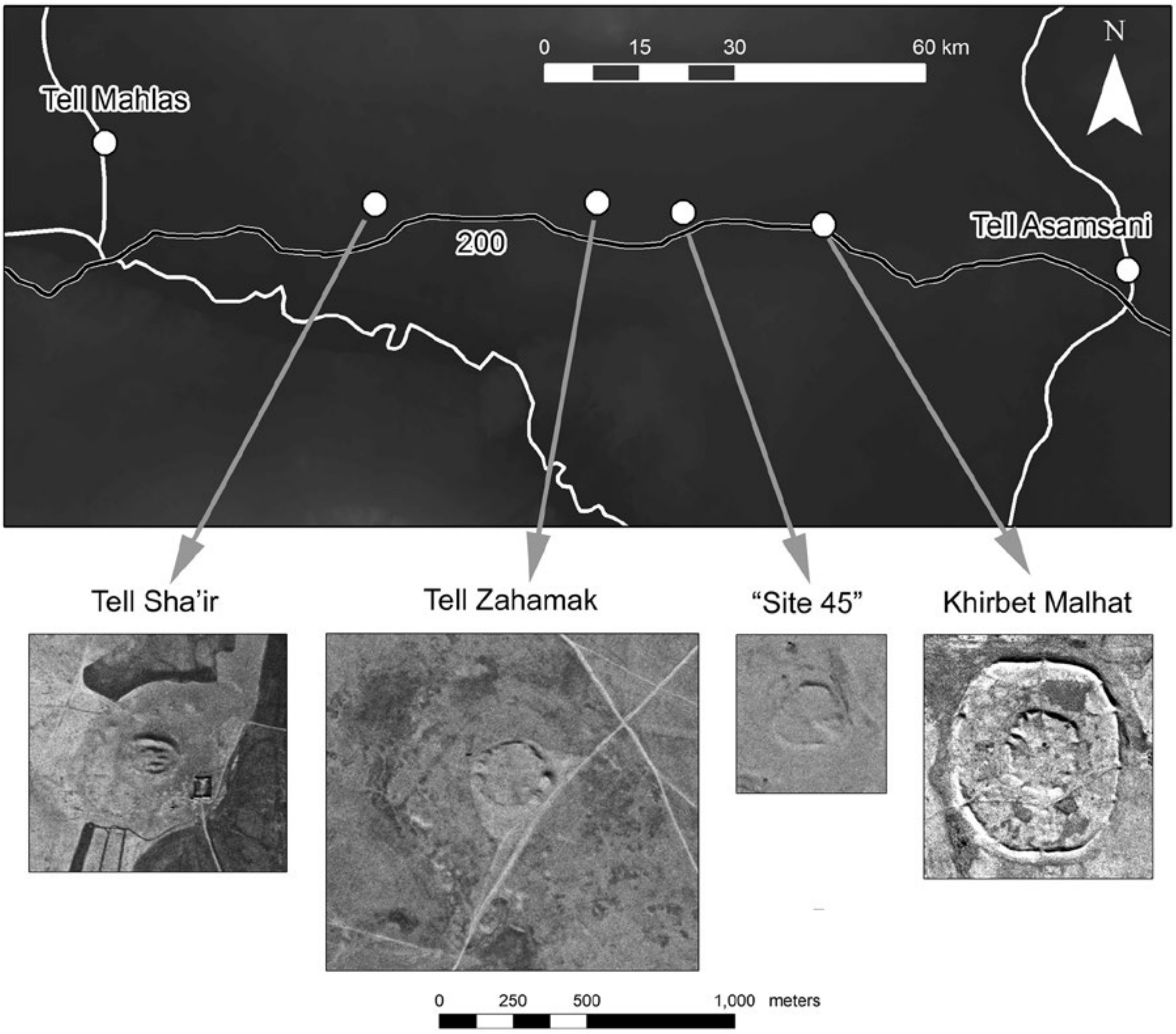


Figure 8.11. Map of the alignment of tell sites in the southern region of the Western Jazira (compare Figure 8.3), with CORONA satellite images of each and rainfall isohyets from the GPCC, processed by Louise Rayne.

Two further features of note exist in this region, both in the vicinity of the Tual ‘Abah mountains. One is the isolated ringwall settlement Site 42 (6 ha; ND), a clear example of this site type with the form of a rounded square. The other is an interesting feature next to the modern village of Bir Sa’id (Site 1065; 1.5 ha; ND). This site appears as a dark-shaded area that is clearly much visited, as evidenced by the straight pathways emanating outwards, crossing its centre like the spokes of a wheel (Figure 8.12). This, together with the location’s toponym ‘bir’, indicates the presence of a significant well. From its location, it appears likely that this was also a water source in antiquity (see below).

Offsite features — hollow ways

While nowhere near as prevalent as in the Khabur basin (see Ur 2003), several major sites in the Western Jazira exhibit ‘hollow ways’ (Figure 8.13); heavily-used routeways for accessing agricultural and pastureland in antiquity that manifest as incised lines in the present-day landscape (Ur 2003: 102–104). The sites that clearly exhibit these emanating in all directions are Tells Mabtuh Sharqi, al-Magher, Bogha, Khanzir, Kharab ‘Arnan, and Mu’azzar. Some examples also exist around Tells Chuera, Mabtuh Gharbi, Hamam Sharqi, and Hamam Gharbi, though these are fainter and mostly concentrated on a single side of each site. None appear to go very far (circa 10 km maximum), and there are no clear examples of the long intersite hollow ways that exist in the Khabur basin (see Ur 2003: 111–112).

Significantly, none exist around the two Dakhliz-variety tells, despite these being located in areas where other contemporary tells do exhibit hollow ways. This further supports the hypothesis of a short and uneven occupation of these sites, at least as large settlements. Meanwhile, the consistency of the absence of hollow

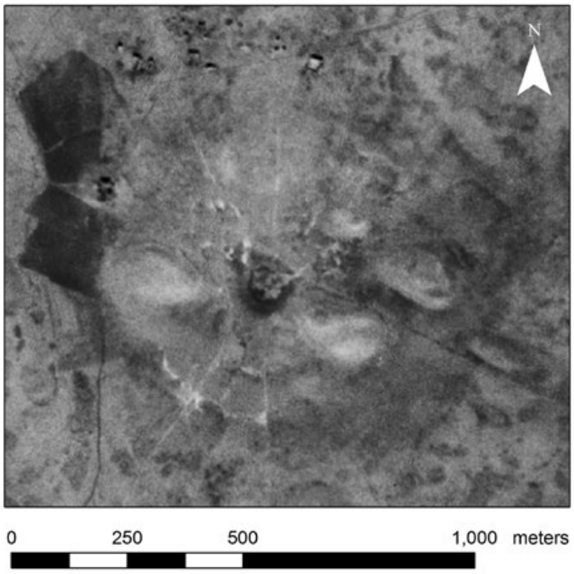


Figure 8.12. CORONA satellite image of Bir Sa'id.

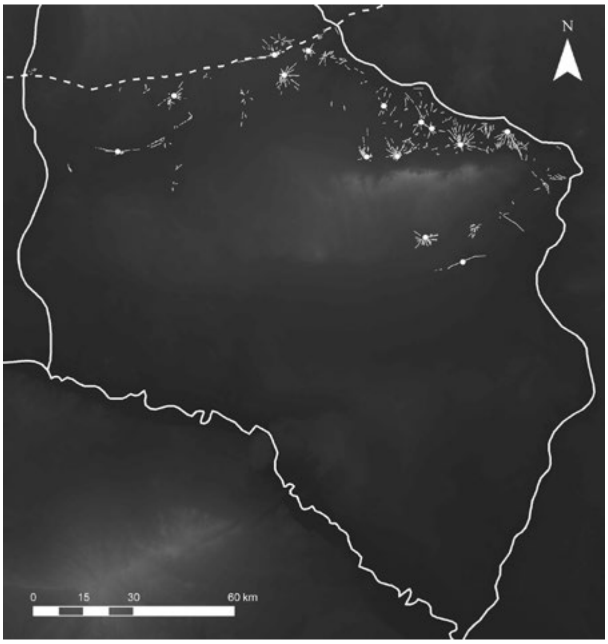


Figure 8.13. Map of the Western Jazira showing the locations of all hollow ways identified by the remote sensing survey, and the main sites these emanate from. Some of the hollow ways depicted in the northeast have previously been mapped by Jason Ur of Harvard University.

ways of any kind in the entire southern half of the Western Jazira, despite the existence of several large tells of a variety of types, is probably better explained by the taphonomic processes of an arid, dusty environment obscuring any traces of ancient paths, as well as the lack of necessity of following the same route for each journey in an area of sparse land control.

Discussion of EBA settlement dynamics

The prevalence of large, well-fortified sites in the semi-arid steppe of the Western Jazira during the EBA naturally poses the question of how and why societies and economies operated in the region, sustaining themselves for the better part of a millennium. Several potential coping strategies that could have been employed to minimise risk have been postulated in recent publications, including agro-pastoralism (Smith, Wilkinson, and Lawrence 2014: 154–159), agricultural extensification (Wilkinson et al. 2013: 185–189), support of large sites by satellite settlements (Kalayci 2013: 237–243), and trade (Wilkinson 2000: 13–14). The EBA populations of the different regions of the Western Jazira likely employed a variety and combination of such resilience methods for survival, tailored to the specific environmental and social needs of each area. However, the different timings of settlement trajectories and the heterogeneous fortified settlement morphologies suggest that the origins of urbanism in the region were equally varied.

Specifically, two distinct zones of trajectories to urbanism can be defined in the Western Jazira. The northern settlement zone (Figure 8.3) sees true Kranzhügel and Dakhliz-variety tells established from EJZ 0 onwards. The general pattern across Northern Mesopotamia at this time is one of previous indigenous centres vanishing in favour of dispersed small settlements and a reduction in social complexity following the collapse of the Uruk expansion until the mid-EBA (circa 3000–2600 BC; Ur 2010: 401–404). By contrast, this zone sees rapid urban growth with the establishment of numerous large fortified centres. This has led Hempelmann (2013: 272) to argue that initial settlement trajectories around the Wadi Hamar were not linked to developments in its vicinity, and based on ceramic similarities (such as *cyma-recta* bowls, Karababa ware, and metallic ware) suggests it to be the product of migration from the Upper Euphrates region (see Figure 8.1). Inhabitants of large sites in that area were not only less affected by the collapse of the Uruk network, with evidence of continuous LC to EBA occupation at many sites, but were also familiar with aspects of urban planning (Hempelmann 2013). This would explain the existence of the central administrative axis and planned street network of Tell Chuera (and presumably other large sites around the Wadi Hamar); indicators of societies with highly organised hierarchical structures

(Meyer 2010b). Such a migration into relatively unknown regions would also explain the immediate construction of fortifications around large sites for protection against real or perceived threats, as well as their subsequent expansions into lower towns as the region attracted further migrants, resulting in the morphologies of true Kranzhügel and Dakhliz-variety tells.

This northern zone was likely colonised as it is a prime location for agro-pastoralist strategies to prevail. Assuming climatic conditions not too dissimilar to the present day,[3] this area would have allowed for sufficient agriculture to produce the amounts of fodder crops necessary to support large sheep herds. These, in turn, would have had ample space for pasture in areas away from wadi courses, along which the majority of EBA settlements were clustered. This would additionally have provided space for the implementation of extensification during dry years (Smith and Wilkinson in press). Together, these practices would also account for the relative prevalence of hollow ways in the area.

The southern settlement trajectory zone (Figure 8.3), by contrast, follows the general EBA settlement pattern of Northern Mesopotamia, with large urban centres not emerging until the mid-3rd millennium BC (Ur 2010: 404–412). Though this area saw a similar influx of population and probable use of agro-pastoralism as the Wadi Hamar region had around 500 years earlier, the reasons behind these processes were likely very different. Since high numbers of sheep holdings are known from textual sources to have been required by major polities by this time (see e.g. Milano 1995), these would have been in the best position to exploit both the empty space and potential for limited agriculture of the southern Western Jazira when conditions were favourable (Smith *et al.* 2014: 161–163, 166–168). This would explain the influx of people and thus rapid settlement increase primarily during the mid–late EBA, presumably originating from newly urbanised centres on the nearby Middle Khabur (Kouchoukos 1998: 421–423). However, this likely occurred in combination with local exchange with mobile pastoralists, or a fluctuating relationship between these two strategies over time. Kouchoukos (1998: 410–412) argues that the commodification of pastoral produce, a result of the growing value of textiles (and hence the wool needed to produce them) following the late 4th millennium BC Uruk expansion (McCorriston 1997), would have made local trade between mobile pastoralists and sedentary farmers a lucrative business around the Jebel Abd al-Aziz.

Regionwide trade doubtless also played a major role in the colonisation of the southern settlement zone. This is especially true south of the 250 mm isohyet, where despite the existence of accessible groundwater sources sufficient for direct human consumption, the low precipitation levels preclude the use of even the most flexible agro-pastoralist strategies, making it ‘doubtful that agriculture was the dominant means of subsistence’ (Kouchoukos 1998: 387). As the numbers of local mobile pastoralists in such arid regions are also likely to have been low, long-distance trade would appear to have been the primary source of income, and indeed raison d’être, of large sites. This hypothesis is given greater credence by the identification of the alignment of four large tells described above (Figure 8.11), but also likely applies to other sites in the area. The probable well of Bir Sa’id, for example, is directly located on a route between Nineveh on the Tigris and Tell el-Sweyhat on the Upper Euphrates (and west thereof) proposed by Wilkinson (2004: 186–187).

It is furthermore possible that the locations of the southern zone’s prevalent ringwall settlements on trade routes account for their morphology. As has been proposed for Tell Beydar, the inner and outer walls of which were constructed and initially used simultaneously, ‘traders were [very likely] allowed to spend the night between the [two] walls, safe from highway robbers but not themselves posing a danger to the sleeping citizens of [the city]’ (Bretschneider 2005: 55). This would explain the very prominent outer walls of ringwall settlements, as well as the empty look of their ‘lower towns’ on satellite imagery, as these areas might primarily have been the locations of temporary traders’ camps rather than permanent structures.

To conclude, the settlement trajectories recorded in the Western Jazira make it clear that there was no single path to urbanism in Northern Mesopotamia, supporting the conclusions of Wilkinson et al. (2014). While the general pattern of dispersed small rural settlements during the early EBA giving way to increased numbers of large urbanised centres in the mid-late EBA is not in dispute, geographical pockets of alternative patterns appear likely. In the case of the northern Western Jazira, this is accounted for by a probable long-distance migration from the Upper Euphrates region, establishing a separate developmental enclave within Northern Mesopotamia. More broadly, the complex and dense EBA settlement structures observed make it evident that the overall exploitation of the Western Jazira (incorporating various subsistence strategies in abundance and to great effect) was a major component of the regional and inter-regional economy to an extent not previously realised. Thus this area is not a ‘marginal’ region, as it has long been considered, but is instead as integral to the study of Northern Mesopotamia as its well-researched fertile regions. While the Western

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[3] Estimates by Kalayci (2013: 99–111) suggest that if anything, conditions in the early 3rd millennium BC would have been slightly wetter than in the present day (see Figure 8.4).

Jazira certainly merits further investigations, especially on the ground, this remote sensing-based survey goes some way to filling in a significant knowledge gap of EBA Northern Syria, illustrating how this methodology can contribute results with widespread ramifications to the known archaeological landscape.

Acknowledgments

Thanks go to all my colleagues at Durham University's Fragile Crescent Project; especially Louise Rayne for the processing of GPCC rainfall data. Special thanks are in order for Veronika Kudlek of the Goethe-Universität Frankfurt am Main for the permission to use her database of the Wadi Hamar Survey, and for Frau Gerti Preuss for providing me with her unpublished MA thesis. Last, but far from least, I wish to express my extreme gratitude to Tony Wilkinson, to whom this paper is dedicated and without whom this study would never have come about.

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How the Hollow Ways Got their Form and Kept Them: 5000 Years of Hollow Ways at Tell al-Hawa

Michelle de Gruchy and Emma Cunliffe

The story of the hollow ways in the North Jazira began more than 5000 years ago, when the collective footprints of people walking to and from their fields, leading their animals to pasture, and travelling between sites became so numerous that they wore away the earth and left paths still visible today. This paper reviews the potential cultural and physical processes behind the formation of hollow ways in the North Jazira, and asks to what extent formation studies may be biased by differential preservation. Whilst taphonomic processes affect all sites and features, recent landscape developments have been particularly destructive to archaeological remains. Despite this, thousands of hollow ways remain, but the reasons why they are preserved have never been examined. In short, this paper explores how the hollow ways got their form and kept them.

Background to the research

In 1980, construction began on the Saddam Dam on the Tigris River at Eski Mosul, which was intended to be the largest dam in Iraq. The accompanying irrigation scheme ultimately covered 750 km^2 and the irrigation canals, developments, and ensuing multi-season cropping would drastically alter the face of the landscape. The Director-General of Antiquities and Museums (DGAM) designated the area a rescue zone, and archaeological teams were invited to participate in a programme of rescue work.

In particular, excavations took place at Tell al-Hawa, the largest tell in the rescue zone (Ball 1990a; 1990b; 1994; Ball et al. 1989). Initially as part of the Tell al-Hawa excavations, and later expanding into a larger project called the North Jazira Project, extensive survey work was undertaken throughout the irrigation zone from 1986 to 1990 (Wilkinson and Tucker 1995). In total, 184 sites were identified and recorded, as well as off-site scatters and features, including hollow ways (Figure 9.1). The project aimed to 'unravel the complex sequence of settlement, land use and communications that evolved within a modest-sized enclave of land' (Wilkinson and Tucker 1995: 1).

Hollow ways are long, linear features typically measuring 70–120 metres wide (Wilkinson *et al.* 2010); the longest (preserved) hollow way in the North Jazira is approximately 5 kilometres. Their remains can still be seen in the landscape today as either slightly indented channels, lines of vegetation or water, or as lines on satellite imagery and aerial photographs (Figure 9.2).

Although there has been interest in the hollow ways for over half a century (e.g., Buringh and Mudiriyat al-Buhuth wa-al-Mashari' al-Zira'iyah 1960; Poidebard 1934; van Liére and Lauffray 1954), it was Professor Wilkinson's research (2003, see also Wilkinson *et al.* 2010) that definitively proved that hollow ways are the result of movement rather than drainage as previously argued by McClellan and others (McClellan and Porter 1995; McClellan *et al.* 2000), supporting van Liére and Lauffray's earlier theories (1954/55). There are three types of hollow way in the North Jazira: those leading from settlements to surrounding agricultural fields, those continuing beyond the fields out to pastures, and long-distance hollow ways that connect sites (Ur 2010; Wilkinson 1993; 2003; see Figure 9.3).

Professor Wilkinson also led the first and only excavations of these features (Wilkinson et al. 2010), providing geomorphological evidence for hollow way formation. Three hollow ways around Tell Brak (numbered 40, 50, and 61) were selected and excavations established that they date back to at least the 3rd millennium BC (Wilkinson *et al.* 2010). Hollow way 40 is particularly valuable for understanding formation processes, since samples were collected from its profile for soil micromorphological analysis (Wilkinson *et al.* 2010). The lowest fill level of the hollow way contained poorly sorted gravel consistent with intermittent flows of water resulting from heavy rain causing run-off from the tell (Wilkinson *et al.* 2010: table I). This process would have helped carve the feature into the landscape. It also sped up an existing process of erosion caused by 'the frequent movement of thousands of domestic animals, plow teams, and travelers' (Wilkinson et al. 2010: 766). It is unknown how quickly these formation processes took place, but Digital Globe imagery on Google Earth, dated to 2009 and 2012, shows the potential appearance of a new hollow way on the lower town of the site of Carchemish, indicating that this process of formation could potentially occur within three years.

Methodology

This paper focuses on the hollow ways identified in the North Jazira Project Survey (NJS) (Wilkinson and

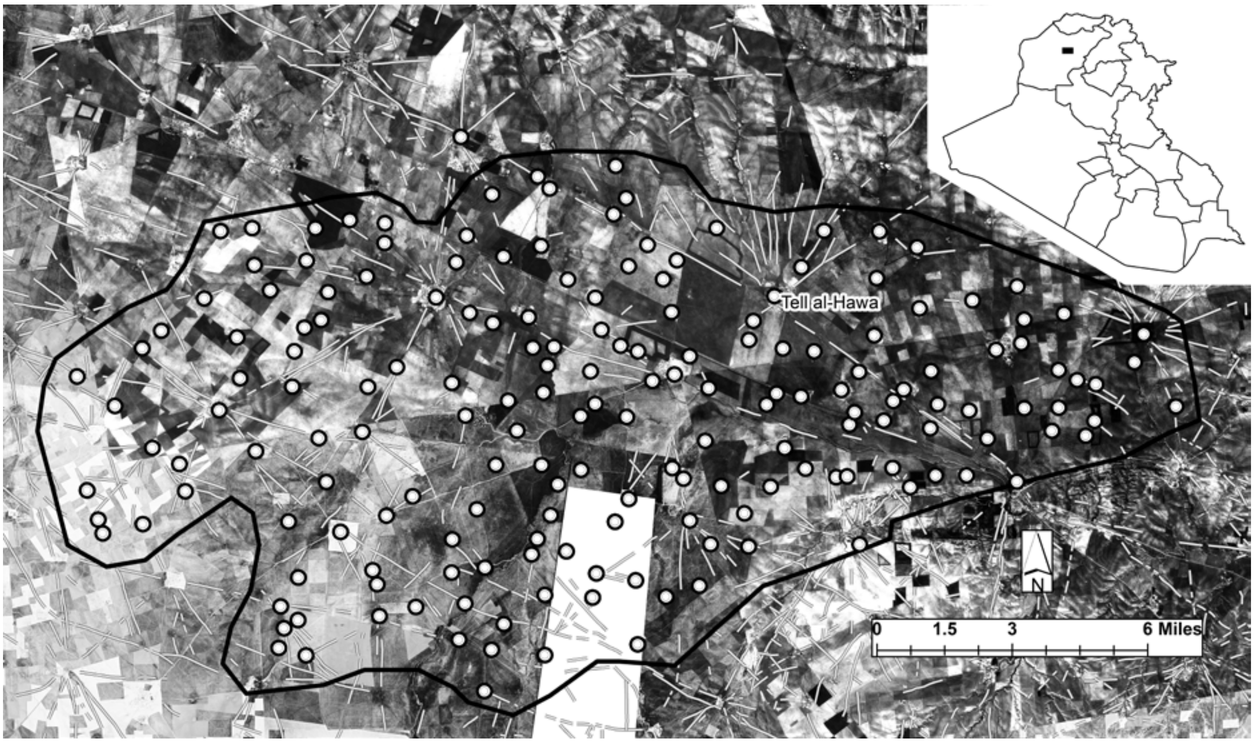

Figure 9.1. Map of the North Jazira Survey location, with sites identified (after Wilkinson and Tucker 1995) and the hollow ways, identified by Jason Ur, marked against 1102 and 1117 CORONA imagery.

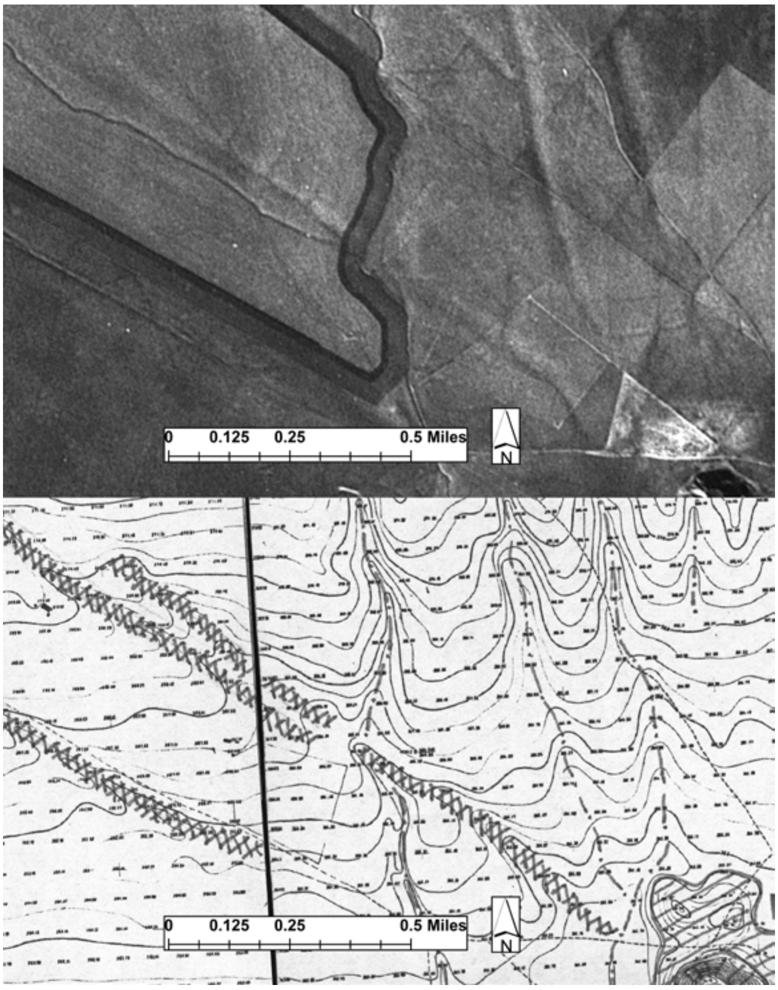

Figure 9.2. (Top) Sections of hollow ways to the west of Tell al-Hawa (in the bottom right corner) on 1102 CORONA. (Bottom) Contour map of the area: cross-hatching indicates hollow ways, whilst dashed-dotted lines indicate wadis.

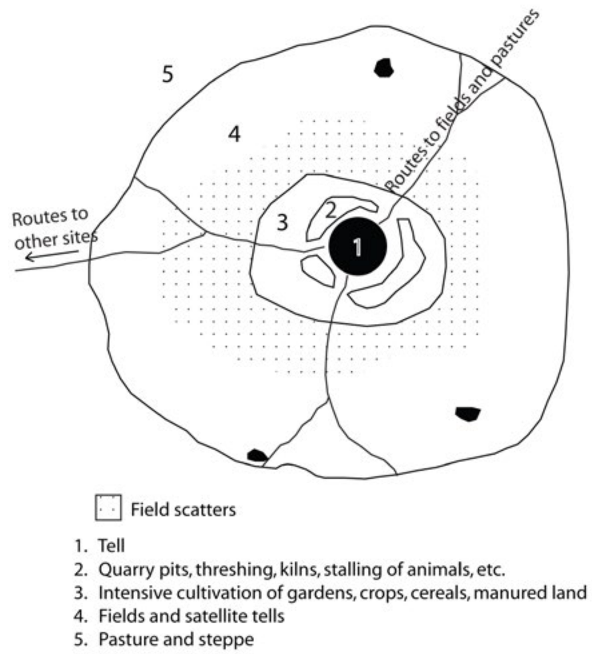

Figure 9.3. “Landscape of tells” based on Wilkinson (2003: 119, fig. 6.16). Schematic view based on field data.

Tucker 1995), particularly the long-distance hollow ways that connect early 3rd millennium BC (Ninevite V, circa 3000–2500 BC) sites[1] in the survey area. The initial work by Wilkinson and Tucker was further developed by Menze and Ur (Menze and Ur 2012; Ur 2003; 2010b; 2010a) when they mapped and created shapefiles of the hollow ways of the entire Jazira in ArcGIS using a combination of survey, aerial photography, and satellite imagery. Their data provides the foundation for the present study. We would particularly like to thank Dr Jason Ur for sharing his GIS data of the area (Figure 9.1). Cunliffe examined additional CORONA imagery, finding further hollow ways. Collectively, images from the the 1102, 1108 and 1117 CORONA missions were assessed (dating to December 11, 1967, December 6, 1969, and May 25, 1972, respectively). Shapefiles of the locations and extents of Ninevite V sites were selected for examination, as were the GIS maps of the hollow ways that connected the sites.

These CORONA images provide early views of the state of preservation of the archaeological features in the area. Additional snapshots over time are available on Google Earth, which hosts Digital Globe imagery from May 13, October 22, and December 16, 2004; from September 23, 2006, October 20, 2010; and a mosaic of SPOT imagery, the dates of which are uncertain (although Google Earth states the entire mosaic is from December 31, 2004, comparison to the SPOT archive suggests that this particular part of the mosaic dates to summer 2006). The analyses were supported by sub-metre contour data, which we are extremely fortunate to have.[2] Ultimately, three likely long-distance route ways were identified and selected for analysis: A, B and C, shown in Figure 9.4.

Examining why the hollow ways formed

The North Jazira is a largely flat landscape without any obvious physical constraints; therefore, movement between settlements was not constricted by the topography. While it is likely that plow teams respected the field boundaries of fellow farmers (Ur 2009), and pastoralists driving their animals to the grazing grounds beyond would do the same; the question remains: what factors guided travellers’ movements between settlements?

Based on crop yield and population density estimates (Wilkinson 1990), settlements during the early 3rd millennium BC were not so closely placed that the fields of one abutted the fields of the next (see Figure 9.5). Travellers could move freely beyond the fields and yet they chose to walk in each other’s footsteps with enough regularity that their footprints collectively carved the long linear hollow ways we observe today. It is possible to evaluate the effort needed to travel along potential routes, using cost analyses in ArcGIS and GRASS. As part of her doctoral research, de Gruchy developed a new method that directly and quantitatively evaluates the constructed models against the preserved hollow ways or other known routes. Models were constructed for easiest, fastest, and shortest (distance) routes between sites factoring both slope and land cover. The land cover was carefully reconstructed with a new methodology de Gruchy developed that uses dated archaeobotanical

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[1] More recently, Lupton (1996) has re-examined the periodisation of sites, and it will be necessary to re-examine the periodisation again in light of the results from the large Associated Regional Chronologies for the Near East (ARCANE) Project; however this is beyond the scope of the present paper. Instead it is assumed that Ninevite V pottery is reasonably iconic, such that Wilkinson and Tucker’s (1995) initial assignments of sites to this specific period are unlikely to change.

[2] The North Jazira Survey was originally denied access to maps or photographs, but Professor Wilkinson visited a Dutch consultancy firm in Baghdad, who possessed aerial photos and a set of Chinese maps. He made traces of these for use in the field. It is possible (and even likely) that if the regime of the time had discovered him using such highly sensitive unauthorised geographical data he would have been arrested and potentially imprisoned. Shortly before the first Gulf War, the firm was required to burn documents — including the maps and photographs. Instead, they contacted Professor Wilkinson, who purchased them with £3,000 from the British Institute. He then ferried them via diplomatic pouch from Iraq to London, where he personally collected them. When copying them into one large and one small set, Professor Wilkinson was forced to cut up the maps to fit the limited reprographic machinery available at the time. They remained with the British Institute for many years but on the retirement of one of the members, Professor Wilkinson was offered the collection. Although the larger set of maps was lost, the aerial photographs and the smaller set remain, for which we are grateful. Extracts from the contour map can be seen in Figures 9.2 and 9.10.

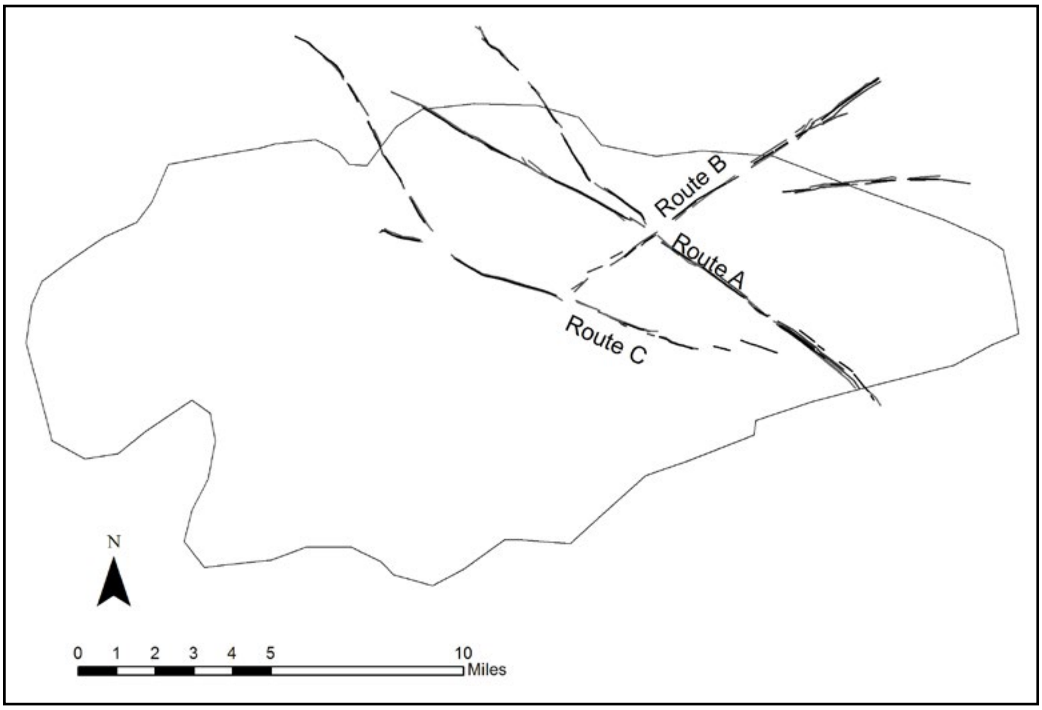

Figure 9.4. Third millennium routes mapped from the preserved hollow ways shown in relation to 3rd millennium sites identified by the North Jazira Project.

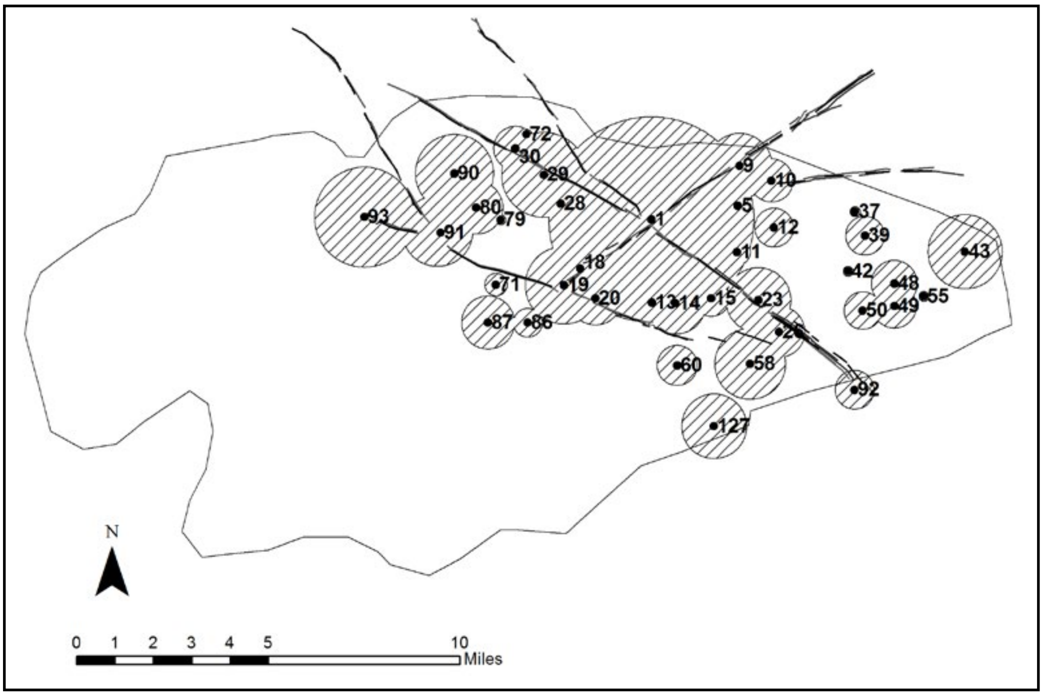

Figure 9.5. Map of the early 3rd millennium, Ninevite V, sites as identified in Wilkinson and Tucker (1995) with buffers representing field areas calculated based on values from Wilkinson (1990).

remains without any assumption that modern land cover in any way reflects what was there in the past (de Gruchy 2017; de Gruchy *et al.* 2016). For the fastest route model, the first velocity-based terrain coefficients were developed (de Gruchy *et al.* 2017), while existing energy-based terrain coefficients were used for the easiest route model (Givoni and Goldman 1971; Pandolf *et al.* 1977; Soule and Goldman 1972). Quantitatively assessing these models against the preserved hollow ways using either a 2-tailed Z-test, or bootstrapping, all three variables are statistically significant to the 90% level but, interestingly, the significance of all three physical variables lies in how little they match the hollow ways. Therefore no physical variable — easiest, fastest, or shortest routes — dictated how people moved through the landscape. Rather, their route choices must have been based on cultural factors.

Seeking permission from the headman

The distances between the larger early 3rd millennium centres in the North Jazira Survey area measure only 3 to 5 km or, at most, an hour's walk. In fact, the entire lengths of the longest routes, Routes A and C, could be walked in four hours; so there is no physical need for travellers (e.g., water, shelter for the night) to stop at any waypoints between any two destinations in the area. Yet, Wilkinson *et al.* (2010: 750) observed 'that the preserved hollow way segments do not run directly between these [al-Hawa, Hamoukar, and Tell Leilan] settlements, but rather extend between the cities and intermediate towns and villages.'

If there was no physical necessity to visit intermediary settlements, regardless of size, it may be that there was a cultural requirement. Tony Wilkinson and Graham Philip have both noted the need to visit local headmen in smaller villages during fieldwork, in Iraq and Syria respectively, in addition to obtaining permission from more senior authorities in larger centres (pers. comm. 2012–2013).

This requirement may have also been a factor in the past. Supporting this idea of needing to seek permission before travelling through a territory is the tablet ARET XIII 5 from Ebla, which is dated to just one hundred years after the end of the Ninevite V Period. Section 37 reads 'without my permission, no one can travel through my country, if you travel, you will not fulfill your oath, only when I say so, may they travel' (translation in Ristvet 2010: 3).

Testing this cultural variable should normally involve the comparison of two different models: The first model would draw routes between only the major sites along the long-distance hollow ways; the second model would draw routes between every site located along the long-distance hollow ways. Then, the two models would be compared quantitatively[3] against the preserved hollow ways. If the model of routes between only the major sites matched the hollow ways more closely, then it would be reasonable to conclude that travel was only between major centres where it is assumed head people would be located. If the model drawing routes between all the sites had the better results, then it would be reasonable to conclude that there was regular traffic between all sites, regardless of whether they were centres or small villages.[4]

However, in this case, the quantitative assessment was not necessary. An interesting, and obvious, pattern appeared once site size was mapped for early 3rd millennium sites in relation to the long distance hollow ways. The sites for the early 3rd millennium BC in the North Jazira Survey area fall into four distinct size categories: those up to 3 hectares in size, those which are 4–7 hectares in size, one site that is 10 hectares, and one site that is 42 hectares (see Table 9.1 and Figure 9.6). There are no sites that fall between these four categories and the first two categories appear to have normal distributions (see Table 9.2). Figure 9.7 displays the sites by size category in relation to the long distance hollow ways.

It is immediately apparent from Figure 9.7 that generally the smallest sites are located away from the hollow ways and the larger sites tend to be located on the long distance hollow ways. Also, the two largest sites are located on different, parallel long distance hollow ways. Therefore it appears, without any need for further modelling, that long distance movement during the early 3rd millennium does not include travel between the smallest sites (under 3 ha). Rather, any relevant authorities from which permission to travel was required were located only in the larger sites (those of 4 ha and over). Figure 9.8 is similar to Figure 9.7 except that it shows all of the hollow ways, not just those classified as long distance hollow ways. Interestingly, the smallest sites remain disconnected from the network with five exceptions: Sites 13, 18, 20, 30, and 92. It is unclear why these smallest of sites are located directly in the path of major long distance hollow ways. The published survey indicates nothing unusual or exceptional about them, but three of the five sites (13, 18, and 20) reach their maximum size during the Ninevite V Period. In contrast, most other sites of comparable size obtained their maximum extent in the

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[3] The methodology for comparing route models to real world routes is detailed in de Gruchy 2016.

[4] In fact, this forms the general framework of what are actually four individual models, since a person needing permission may equally decide to take either the fastest or the shortest route to the headman. For this reason, it would be necessary to run both the models described with the fastest routes drawn between sites, then run both models again with the shortest routes drawn between sites and compare the results of all four.

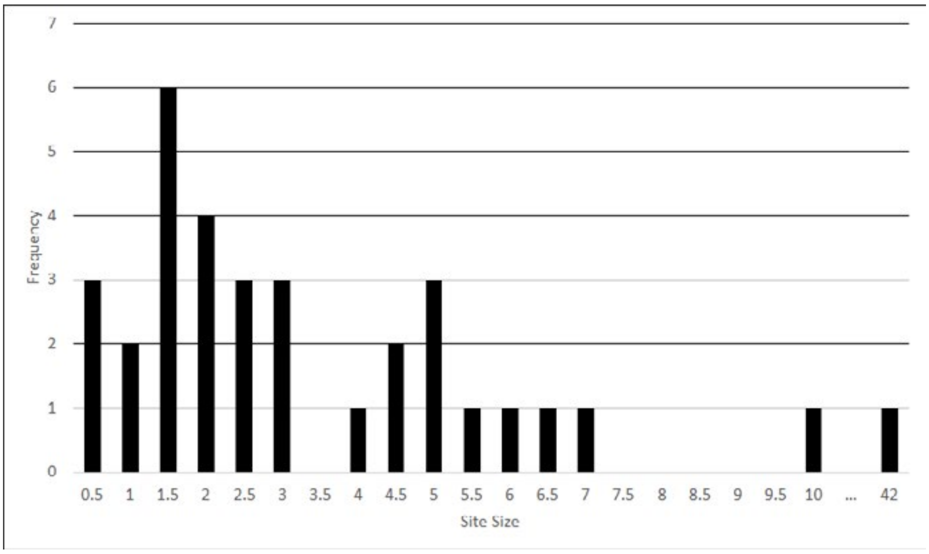

Figure 9.6. Histogram of Ninevite V site sizes, as presented in Wilkinson and Tucker 1995: Appendix C.

later 3rd millennium or Middle Bronze Age (Wilkinson and Tucker 1995: Appendix C).

Table 9.1. Site sizes by category in the North Jazira Survey.

Size (ha)	Number of Sites
0.5	3
1	2
1.5	6
2	4
2.5	3
3	3
3.5	0
4	1
4.5	2
5	3
5.5	1
6	1
6.5	1
7	1
7.5	0
8	0
8.5	0
9	0
9.5	0
10	1
...	0
42	1

Table 9.2. Descriptive statistics for sites in the up to 3 ha size category and the 4–7 ha size category.

Sites under 3 ha			**Sites 4–7 ha**	
Min.	0.4		Min.	3.8
Mean	1.6		Mean	5.2
Median	1.5		Median	5
Mode	1.5		Mode	5
Max.	2.8		Max.	7.2

This suggests that for whatever reason, these exceptional sites were an important part of the Ninevite V settlement network. Also, if the larger sites really are centres controlling tiny villages, then Thiessan Polygons (while not perfect) should provide some sense of what the territories of these centres looked like. Thiessan Polygons are created in ArcGIS through marking the separation of the space between sites. Lines are drawn at the mid-points between the sites to form the polygons. In this case the lines are drawn at the mid-points between centres (i.e., the larger sites), which are then assumed to be power centres in control of the smaller village sites. Looking at Figure 9.9, an interesting pattern emerges. Whenever a long-distance hollow way passes through a Thiessen polygon, it consistently runs through the centre associated with that polygon with only two exceptions. The first is the polygon associated with Site 43, which contains a hollow way that appears connected to the tiny village Site 10 and nothing else, possibly indicating the hollow way belongs to a different time period. The second exception is along the southernmost east–west route (Route C): here the Thiessen polygon associated with

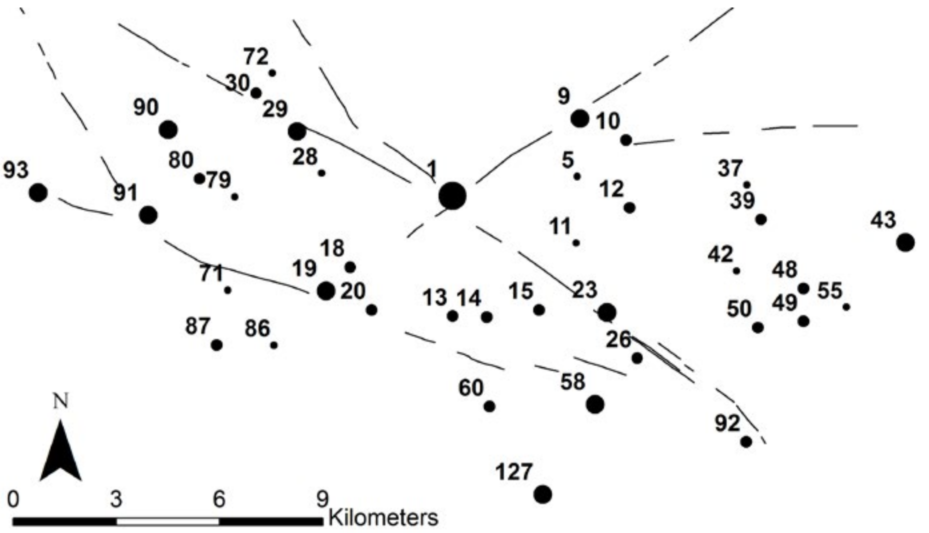

Figure 9.7. Sites mapped by size category in relation to the long distance hollow ways.

Site 14 covers the central portion of the route, while Site 14 itself does not appear to be directly on the route. Instead a hollow way connects Sites 20, 13, and 14, apparently deviating from the main route connecting Sites 19, 58, and 92. Finally, another pattern emerges: if a long-distance hollow way does not pass through a centre (Site 90), then it also does not pass through the associated polygon.

Returning to the polygon associated with Site 14, it is hypothesised that the hollow way segments that appear to form Route C, which connect Sites 20, 58, and 92, actually belong to a time period other than the early 3rd millennium. Instead, it is proposed that Route C originally ran between Sites 20, 13, 14, and 23, then down to Site 92, with a new route branching off from Site 23 to Sites 58 and 127. This would account for the discrepancy observed in the association between hollow ways and the Thiessen polygons of centres.

In order for this theory to hold, hollow ways would be needed where none were previously observed. In fact, an examination of new CORONA images identified possible additional hollow way segments running from Site 19 towards Site 14 and onward to Site 23; and further new potential segments from Sites 20 to 13 and 14. Unfortunately, a modern road runs between Site 14 and Site 23, so it is not possible to establish if there was a hollow way there or not. The other location checked for missing hollow ways was the area from Site 23 to Site 58, down to Site 127. There are many drainage channels and hollows running between Site 58 and Site 127, so it was difficult to be certain whether one of them was a hollow way, and nothing could be seen between Site 23 and Site 58. Nonetheless these newly identified segments do support the proposed path of Route C through Site 14.

The patterns observed suggest that the area of the North Jazira Survey, like the area around Tell Leilan (Schwartz 1989; 1994), is organised into complex chiefdoms with local centres that have control over the surrounding villages. The traffic to/from these villages is much lower, perhaps only the local villagers, and does not seem to leave any traces. Instead, most traffic is directly from centre to centre where, if permission does need to be gained, it is sought from the local chiefs in the centres and not in every little village. Writing about the later 3rd millennium BC, Ur (2009: 200–201) observes that it is the provincial elites who the ruler of Nagar (Tell Brak) was obliged to visit on his travels. Likewise, the Ebla tablet cited earlier (ARET XIII 5) is a treaty between Ebla and Abarsal — two centres, as opposed to a centre and a village. It is therefore particularly interesting to consider the polygon associated with Site 90. Why is this centre, and the associated territory predicted by the Thiessen polygons, avoided by the long-distance hollow ways?

The preservation bias

One possibility, already hinted at in the discovery of a previously unknown route section, is differential preservation. It may be that some routes appear absent as the evidence for them has been destroyed. If we can understand why some hollow ways remain while others are lost, we may be able to reconstruct past landscapes with greater accuracy, thereby improving our interpretations.

This part of the study used the previously selected route shapefiles for the three routes chosen and the site extent shapefiles determined by Ur (partially published here (Ur 2010b), but additional unpublished data was also supplied). Whilst survey data provided the 3rd

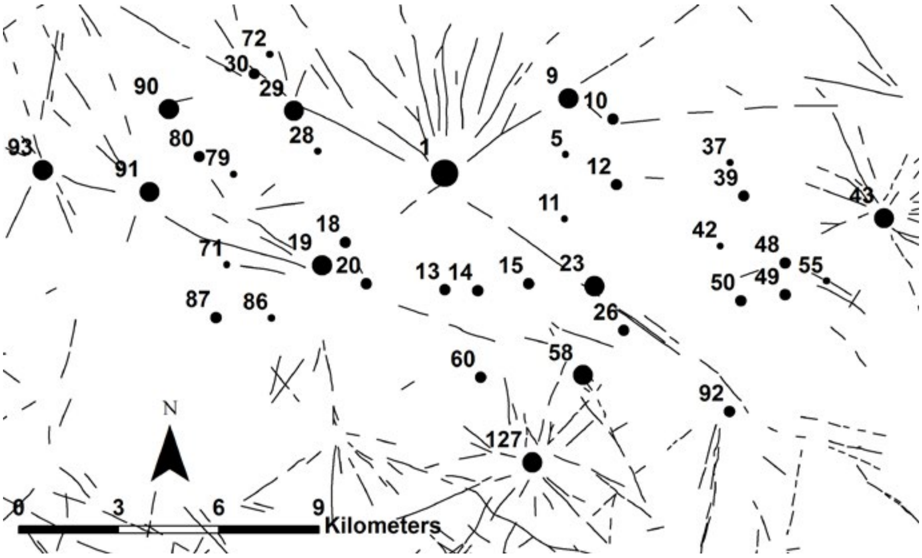

Figure 9.8. Sites mapped by size category in relation to all hollow ways.

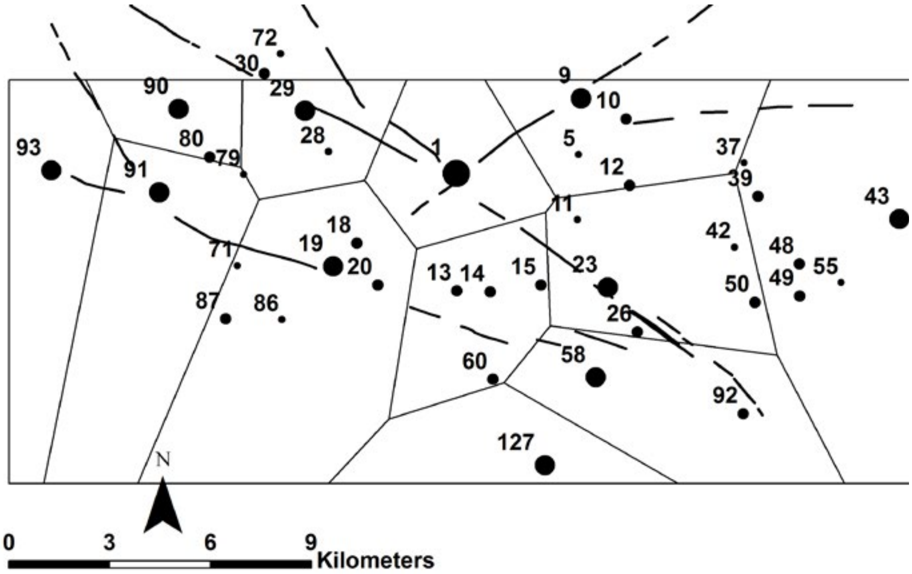

Figure 9.9. Thiessen polygons overlying sites mapped by size category and long-distance hollow ways.

millennium site areas, as indicated by pottery scatters for all sites (Wilkinson and Tucker 1995), the locations of the precise boundaries were not known. Therefore, the maximum possible site extent and potential boundaries were calculated from the visible extent on CORONA. All mapped routes either began or ended at a CORONA site boundary, or passed adjacent to one. The maximum possible original route length between settlements in the 3rd millennium was then estimated.[5] Ur had access

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[5] Lengths of Routes A and B are calculated excluding maximum dimensions of Tell al-Hawa as calculated from CORONA, although this does not represent the size of the site during the Ninevite V period, when it was approximately 54% of the later obtained maximum size (77.1 ha versus 42 ha). The calculation of length for Route C on both the estimated original route length and the length of route remaining on Google Earth contains a segment of route between sites 19 and 20 that was identified by the authors during analysis of additional imagery unavailable to Ur. Since it was, however, presumably present as part of the original route, and is still visible on the Digital Globe image available on Google Earth (dated Oct 22, 2004) this length is also included in calculations. Finally, it should be noted that where Route A meets site 92, numerous parallel hollow ways were identified in the original survey work. Only one length has been used to calculate the original route, although it is acknowledged that multiple routes may have been in use, and the shortest route may not be correct. The

Table 9.3. Changes in amount of route remaining over time.

	Original Length (m)	**Remaining length identified by Ur (m)**		**Remaining length identified on Google Earth (m)**	
Route A	16590.26	11281.03	68%	8848.74	53%
Route B	7592.729	3689.92	49%	2572.94	34%
Route C	21424	10779.8	50%	3666.39	17%
Totals	45606.99	25750.75	56%	15088.07	33%

to some satellite imagery and aerial photographs that were unavailable in this study, so his data were also used to estimate the length of the routes remaining in the 1960s. The shapefiles were then imported into Google Earth, and the lengths of each route remaining in the 21st century were estimated (using the Digital Globe imagery) (Table 9.3).

The original research by Ur identified 19 route segments. A re-examination of these segments on Google Earth's imagery found only nine still remained. Of these, six were shorter, two were the same, and one segment was longer than previously thought. Route C is the least well preserved: today only 17% of it is left, compared to 53% of Route A. However, looking at all three routes, only a third of the original route network remains today. If this rate of attrition continues, the routes that were once a defining feature of the region will soon be lost. So what has affected their preservation?

Route use intensity

The first option to consider is whether routes that appeared to be used more (i.e., appear more deeply incised on imagery) were more likely to be preserved. As acknowledged by Wilkinson and Tucker (1995: 27) 'Although modern geographical theory postulates that interaction (i.e. traffic) between settlements should be proportional to the size of the settlements ... this cannot be assumed for the Bronze Age,' or any other age. Therefore, settlement size will not be considered here.

None of the remaining route segments are classified as 'broad' hollow ways, i.e., the wider hollow ways that are usually short radial routes from sites to fields and pasture. (The broad and narrow classifications are taken from Ur 2010, Map 2, and Wilkinson and Tucker 1995). Five were 'narrow,' and most likely older than the Islamic date often ascribed to them (see Wilkinson 1995: 54 versus Ur 2010). The remainders are unclassified.

As the graph in Figure 9.10 shows, sites on some routes were occupied more frequently than sites on other routes, theoretically leading to deeper, wider, or more slowly infilled hollow ways that would leave clearer traces. However, while the four sites on Route B were the most frequently occupied, sites on Route A were the least frequently occupied, and yet still appear to be the best preserved, both in the 1960s and today.

Water erosion

Given the gradient of the Jazira, 5000 years of weathering could simply have eroded the routes. Contouring, taken from the Chinese maps obtained by Professor Wilkinson, shows the terrain is continuously sloping, and is therefore particularly susceptible to erosion. 'Because the land rarely slopes at gradients of less than 1:300, runoff can always be generated once the infiltration capacity of the soil has been exceeded. As a result, drainage concentration features (rills or wadis) can form everywhere, a crucial factor in the development of certain man-induced features such as hollow ways' (Wilkinson and Tucker 1995: 4).

All three routes will have conducted a certain amount of water as none of them are on a direct E–W line across the contour. Route B in particular runs NE–SW (downslope) and would potentially have been the most eroded by water flow. Certainly the hollow way segment between Site 9 and Site 1 was so deeply incised it was visible on contour maps (Figure 9.11), as was the segment between Site 91 and Site 19, amongst others. However, despite numerous periods of erratic rainfall, erosion is unlikely to be a major cause of feature incision. A wadi (visible on multiple CORONA satellite images, for example Figure 9.12) runs directly N–S past Site 9, and it and its drainage tributaries cross the deeply incised hollow way segment in several places, presumably channeling water away from the route. Another wadi is visible running parallel to segments of Route C (between Site 20 to Site 92), and also between Site 30 and Site 29 on Route A, so again, water was presumably conducted into the wadis, channeling the erosive sheetwash away from the hollow ways, limiting the erosional effect. This is not to say that erosion has

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length of segments remaining for this section is calculated using only the longest segment still visible in this area.

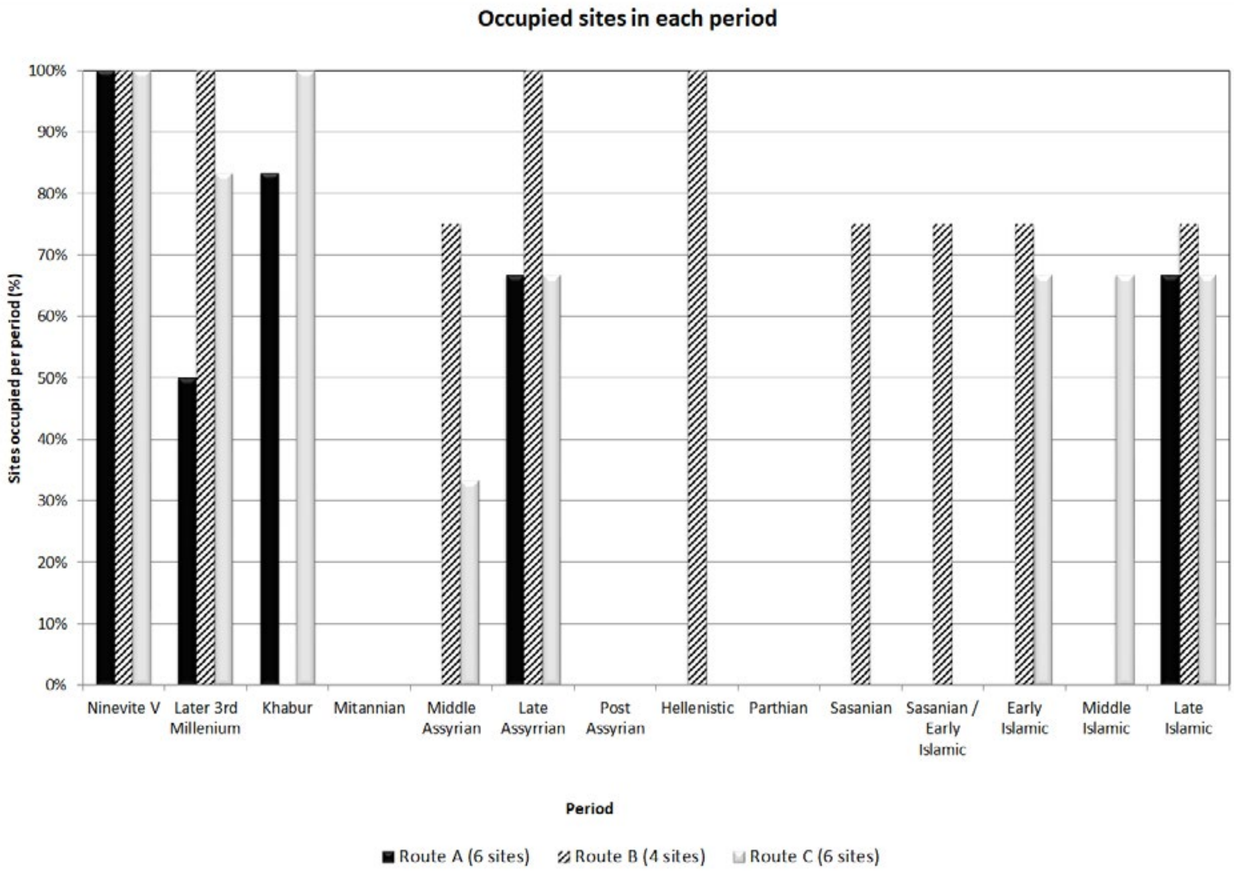

Figure 9.10. Percentage of sites on each route occupied in each period. Hashed lines indicate sites that have only trace occupations in each period. Chronology and occupation are taken from Wilkinson and Tucker 1995.

played no part, only that it is not the sole, most likely, or even main, contributor.

Modern effects

Recent human occupation is the most likely cause of feature loss. Major resettlement took place in the 1930s, encouraged by the British Mandate. By the time the aerial photographs and CORONA images used by Wilkinson, Ur, and others were taken in the 1950s and 1960s, the area had been resettled and turned to farmland. Even then, villages were fewer and smaller than during the 1980s when the al-Hawa survey work took place. Farmsteads lacked irrigated gardens, and fields were large and extensively fallowed. In 1970, the Jazira was considered to be largely composed of desert and to be particularly hard to irrigate, as water flowed in deeply incised valleys (Smith et al. 1971). Numerous wells were dug (and later drilled) to provide water, but by the mid-1980s much of the groundwater was no longer accessible through dug wells due to over pumping, and the drilled water was only suitable for animal husbandry or well-drained irrigation (Wilkinson and Tucker 1995).

In December 1983 the first stage of the massive Kirkuk (renamed Saddam) Irrigation Project was opened, followed in 1991 by a large supplemental irrigation project, the North Al-Jazira Irrigation Project, and the subsequent East Al-Jazira Irrigation Project. These were part of a scheme to ultimately irrigate 250,000 ha of the Al-Jazira plain. The plan, particularly the North Jazira Project, called for a linear-move sprinkler irrigation system utilising an extensive network of concrete lined canals, pipelines, feeder roads, agricultural complexes, new settlements, and massive mechanical irrigators. Together with the resulting irrigated multi-cropping, the landscape, and the archaeological sites it contained, were drastically altered (Ball et al. 1989), with severe effects on the archaeology.

Agriculture

Fulfilling the goals of the Jazira Project, agriculture has become more intensive and more widespread, made possible by a significant increase in irrigation, and tractors. While the total amount of agricultural area has not really increased since the 1960s, the number of tractors has increased significantly (see Figure 9.13). In 1961 there were only 3300 but by 2000 there

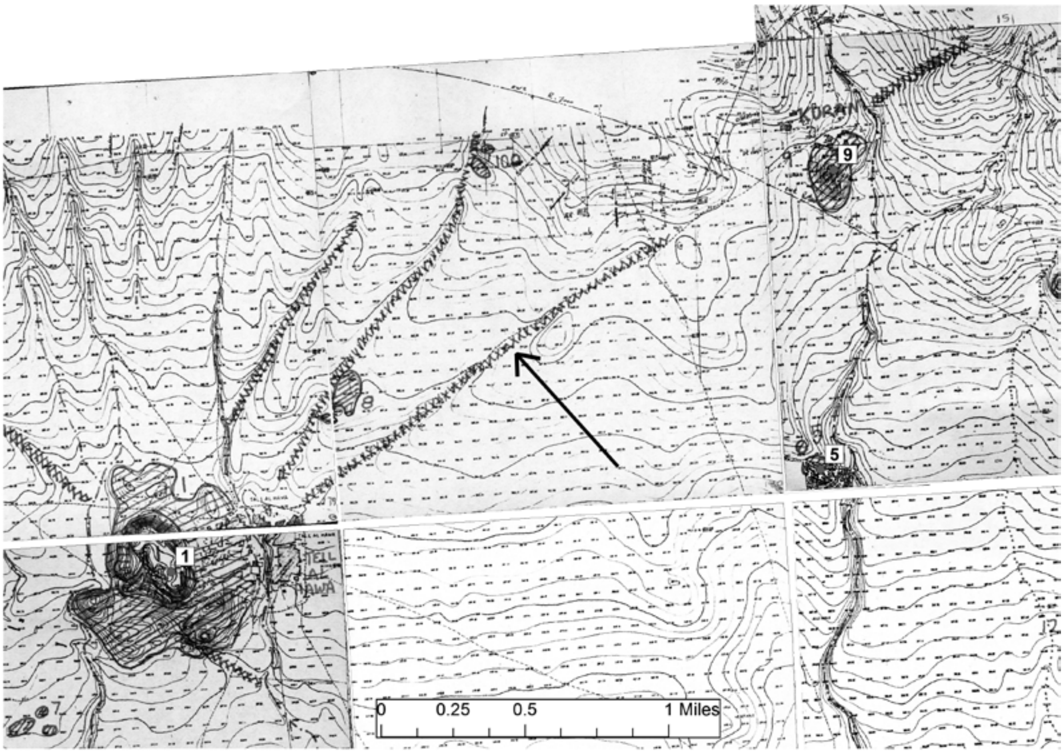

Figure 9.11. The hollow way segment between Site 1 and Site 9 on the contour map: Hollow ways are marked with cross-hatching. The N–S wadi running through the hollow way past NJS 9 is also visible on the far right: probable wadis are marked.

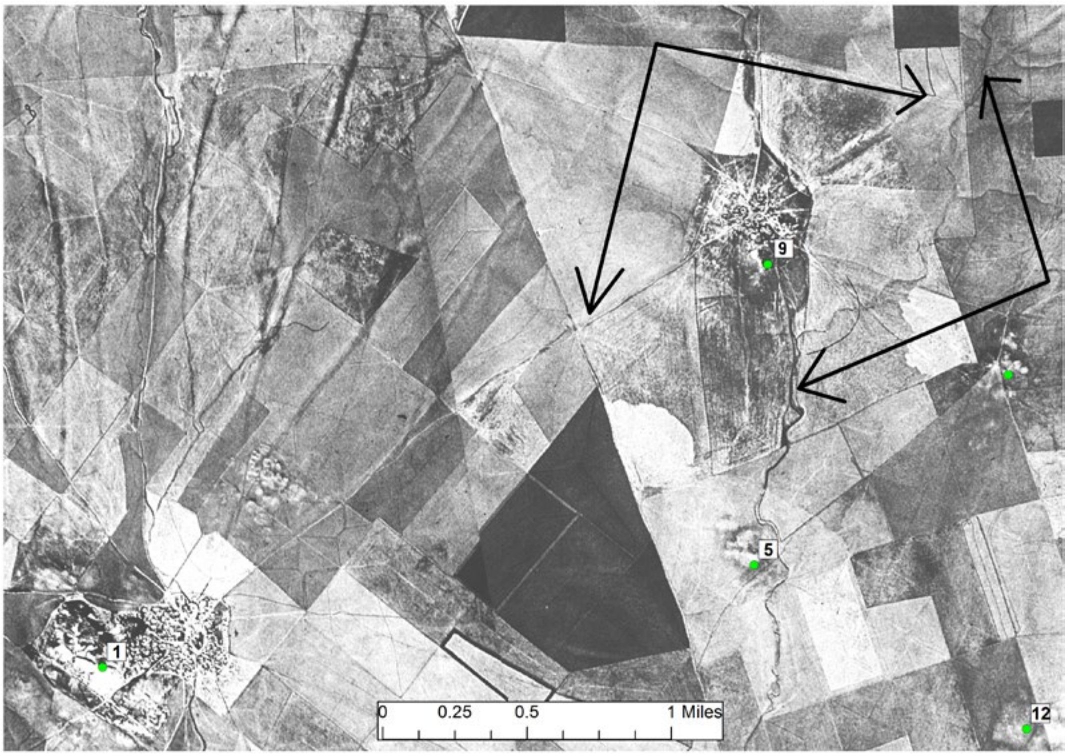

Figure 9.12. The hollow way segment between Site 1 and Site on 1108 CORONA: The top arrows indicate the hollow way. The N–S wadi running through the hollow way past Site 9 is marked with the lower arrows.

were more than 46,000 (FAO Statistics Division 2013). All hollow ways in this area that are not buried under houses, or built over in some way, are in fields — none are in scrubland. Prior to the project, this area had been under tractor plowing for at least 50 years: plowing marks have been visible since the CORONA images were taken. It is often remarked that tillage brings sites to the surface by churning up anthropogenic soils and pottery sherds, but in the case of hollow ways there is nothing to reveal, and tillage will instead slowly destroy subtle (and even major) topographic features (Cunliffe 2013: 57–66; Ur 2010a). Today, double cropping is standard practice, increasing not only the number of times the field is ploughed, but also the amount of time the soil is open to erosion. Natural erosion can cause significant infill that makes it hard to detect the remnants of hollow ways (Wilkinson *et al.* 2010), and this is strongly exacerbated by agriculture. In addition, the small strip fields that marked early agricultural practices are largely gone: most fields are now larger, single crop fields that are easier to use modern machinery on.

Wadis operate under many of the same principles as hollow ways — they are long indented channels that can conduct water and disrupt modern agricultural machinery. When discussing the demise of perennial wadis, Wilkinson and Tucker (1995: 4) remarked: 'It is clear that once flow diminishes below a certain interval, such as one significant flow every two to three years, it will fail to evacuate much of its sediment load. If plowing takes place every year or two on the adjacent terrain, lateral plough-wash will choke the valley floor, and the wadi channel will cease to present an impediment to plowing. As a result, plowing will operate freely across the former wadi bed, thus reinforcing its demise as a hydraulic feature. Such factors clearly operate today with the result that many wadi floors are barely perceptible.'

Many wadis no longer exist, and this programme of intensive (and intensifying) agriculture is almost certainly responsible for the final demise in numerous hollow ways. For example, a section of Route C runs adjacent to Site 20, Site 58, and on to Site 92. The CORONA imagery indicates that a wadi runs parallel. However, the 2004 Digital Globe image available on Google Earth demonstrates that the wadi has been ploughed out, as has most of the hollow way.

Irrigation

In order to achieve the expansion in agriculture, irrigation networks now crisscross the area. In addition to the main, large concrete irrigation channels, a number of smaller irrigation channels connect them, and numerous small dug channels branch off these. Although the deep excavation of the huge channels allowed the discovery and recording of many more sites than would otherwise have been possible (noted in Wilkinson and Tucker 1995), they cause extensive damage to the fragile hollow ways (Cunliffe 2013: 69–72). For example, both Site 29 and the adjacent hollow way were discernable on the SPOT imagery from Google Earth (Figure 9.14), but the creation of the concrete irrigation channel destroyed part of the feature, as well as a section of the site.

Even small dug channels can be destructive. THS 8 is a Halaf site, which 'lay in the middle of a large fallow cotton field, which had eradicated its edges. Because the process of making the irrigation furrows had destroyed the mounding of the site, masked the lighter colour of the anthropogenic soils and reduced sherd visibility, it is possible that even intensive field walking might have overlooked this site' (Ur 2010a: 44).

When viewed as a proportion of agricultural land, the increase in irrigated land is clear, with worrying implications for the archaeological resource. Figures from the Food and Agriculture Organisation (FAO) estimate the total agricultural area in Iraq has remained more or less the same. As shown in Figure 9.13, the total area equipped for irrigation, on the other hand, has steadily increased from 2.9% of the land in 1961 to 8.1% in 2011 (14% of agricultural land to 43% of it — almost half!) (FAO Statistics Division 2013). This is perhaps due to the steady decline in the levels of the Euphrates and the Tigris and increasing pressure on dropping groundwater. In addition, a severe drought hit the Middle East between 2007–2009 (IRIN 2009; Trigo et al. 2010), putting further pressure on limited water supplies; Northern Iraq was particularly badly affected. This increasing intensity in irrigation poses a serious threat to sites and features.

Bulldozing

Supporting the move away from strip fields to large, mechanically plowed, irrigated fields, large sections of the region have been bulldozed. In particular, gravity fed irrigation systems such as this need flat surfaces, so a large number of the sites are now flattened. While hollow ways may become collateral damage, often their shallow nature protects them. This can be seen at Site 8, adjacent to Route B (Figure 9.15): the site has been bulldozed flat, but the hollow way is still visible.

Development

Of course, the increasing agriculture requires people, visible in the concurrently increasing development. This also poses a clear threat to sites (for details of the damage done by development, see Davies 1957; Huisman 2012; Williams et al. 2007). Using GIS, settlements within a 4 km radius of the hollow ways were examined. They have increased in number and in size by 53%, from

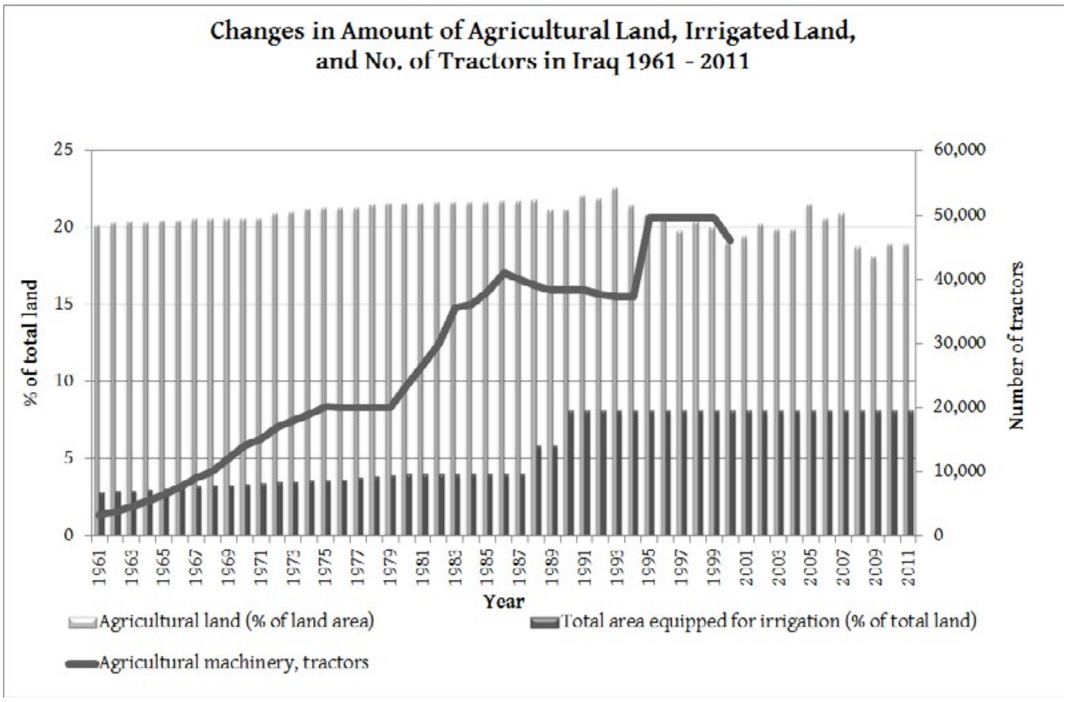

Figure 9.13. Changes in the amount of agricultural land, irrigated land, and the number of tractors between 1961–2011 (FAO Statistics Division 2013).

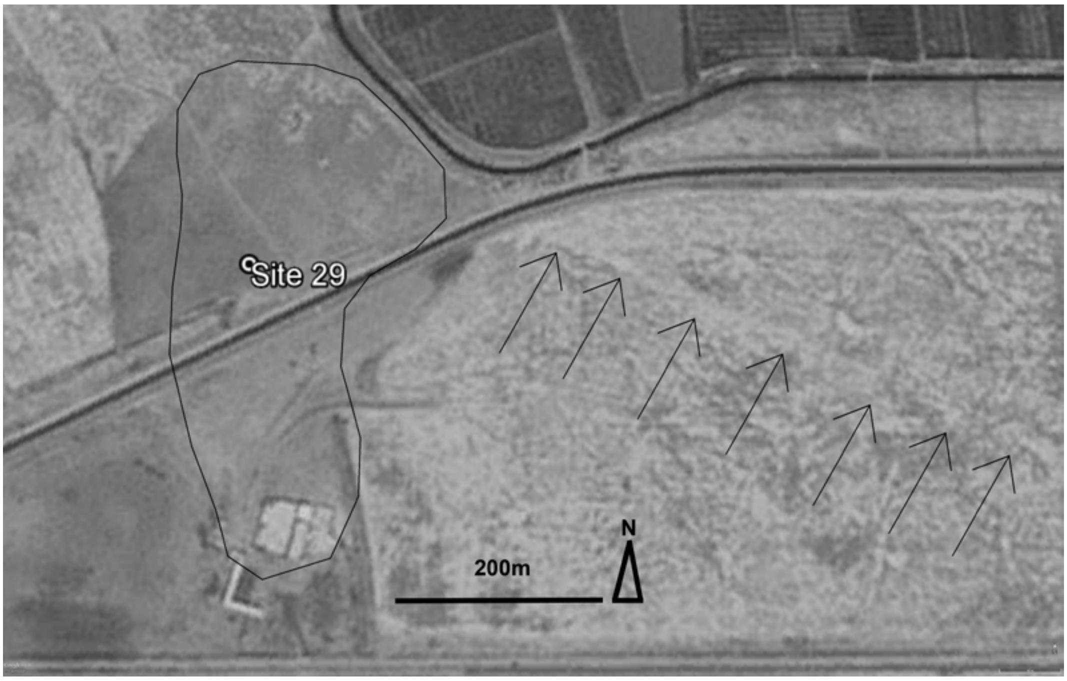

Figure 9.14. Line of the hollow way to the east of Site 29 on the SPOT mosaic available on Google Earth.

Figure 9.15. Route B and Site 8 on 2010 Digital Globe image, and 1102 CORONA (inset bottom right). The inset shows the site in 1967, compared to its appearance after bulldozing. However, Route B is visible on both images.

19 settlements covering 478 hectares on CORONA, to 21 settlements covering 1017 hectares in 2010 (as mapped on Google Earth).

Three settlements went out of use and were turned to fields. Twelve of the examined settlements are on or surround Ninevite V sites, and two are on later settlements. This does not include small single farmsteads, which are extremely numerous.

When examined on early CORONA and aerial photographs, all three routes were outside settlements with the exception of the parts of Route B, which passed through Tell al Hawa, and the parts of Route C that passed through Site 93. Five percent of Route A is now covered, 17% of Route B, and 8% of Route C.

As hollow ways are (today) very shallow features, their traces will have been completely destroyed. An example of the largest settlement increase can be seen at Tell al-Hawa (Figure 9.16), where, in 1967, approximately 700 m of Route B had been destroyed by the village. Examination of Digital Globe imagery from 2010 suggests that circa 1250 m of Route B has been covered by development and destroyed, and circa 600 m of Route A.

Roads

Several hollow ways have also been damaged by roads. On the CORONA imagery, the area is covered in small tracks, identifiable by their higher reflectance/white upcast. As the occupation intensity of the area has increased, while some have fallen out of use, many tracks have been gravelled and then, over the last decade, paved. Whilst there is evidence (albeit not from Iraq) that even these simple, uncovered tracks can damage and erode sites (Kincey and Challis 2010), it is the paved roads that are the greatest threat. Upstanding features are flattened and the topsoil is stripped, before the soil is compacted and asphalt, containing harmful chemicals that can leach into archaeological layers, is applied (Davis et al. 2004). For particularly large roads, foundations are also dug. While small roads at least are not necessarily that damaging to hollow ways, road building removes the two main signs that enable their identification on imagery: increased moisture retention and increased vegetation.

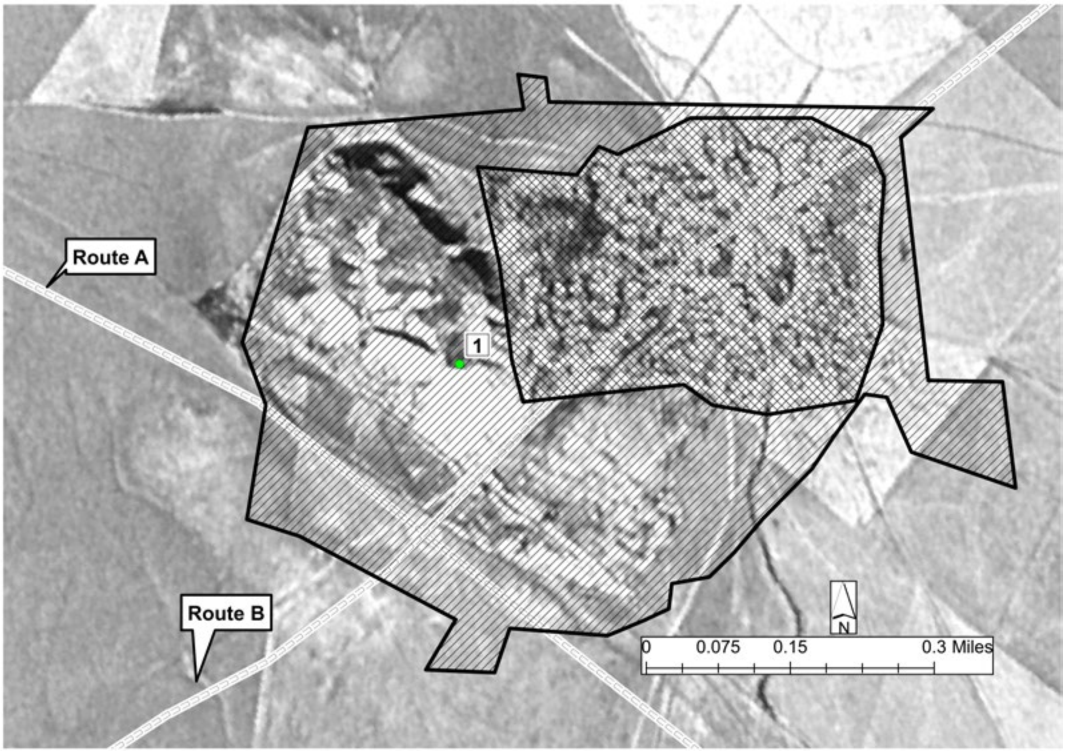

Figure 9.16. The increase in development at (and on) Tell al-Hawa, NJS 1. The lines indicate Routes A and B passed the tell. The cross-hatched area is the size of the adjacent village on 1108 CORONA (1969). The single hatched area is the size of the modern village on the lower town, surrounding the tell. Considerably more of the hollow ways are now covered and destroyed.

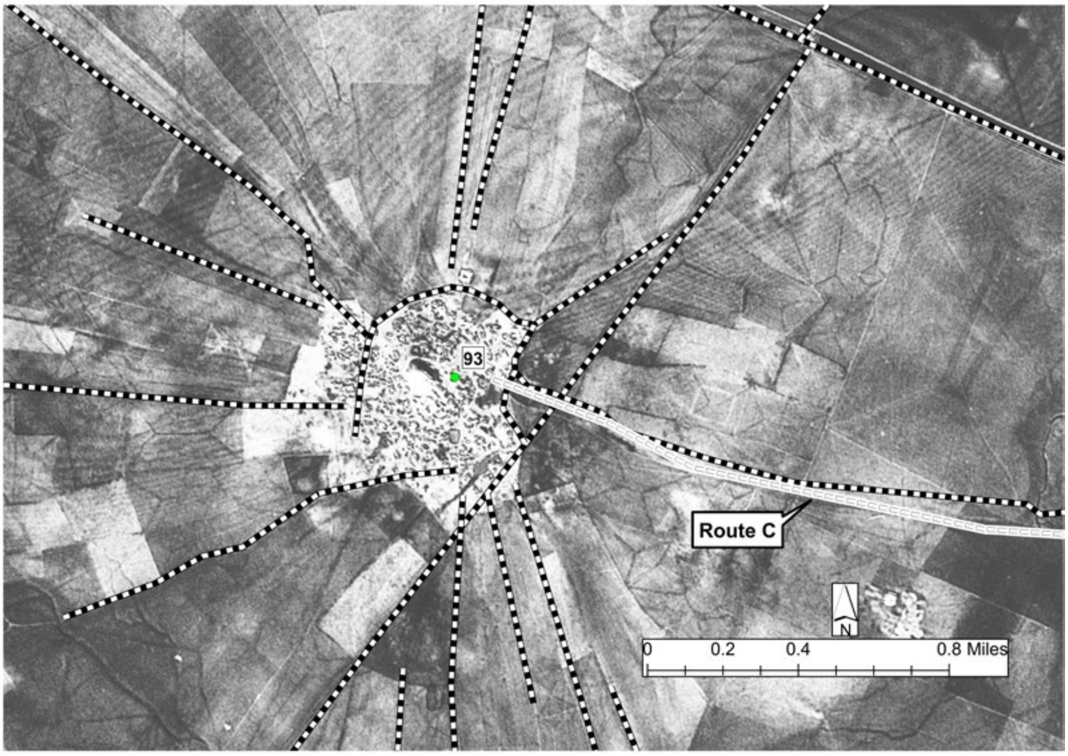

Figure 9.17. Radial roads and tracks surrounding the modern (1960s) town around Site 93 on Route C. These are mapped from all three CORONA images, but displayed here on 1108 CORONA. Route C is indicated running east–west in the right of the picture, paralleling one of the tracks.

Figure 9.18. Modern routes and roads surrounding the modern town around Site 93 on Route C. These are mapped from 2010 Digital Globe imagery on Google Earth. Route C is indicated running east–west in the right of the picture.

In some regions, hollow ways have been destroyed by new roads that mirror the old hollow-way systems. In the North Jazira, at least, the irrigation system has worked to the benefit of the hollow ways. Site 93, visible on the 1102 mission CORONA (1967) in Figure 9.17, is surrounded by a recent settlement even in 1967. In many respects, access to the strip fields surrounding the settlement follows the old radial patterns known from ancient settlements. The more recent modern roads and tracks, however, are constrained by the irrigation channels, with the result that many routes are circuitous and complicated. These routes are almost never direct, or even short, leaving the hollow ways alone (Figure 9.18).

The future: population projections

This brief examination has found extensive evidence of the damage to the ancient routes caused by increasing occupation intensity. The population continued to increase from the early resettlement plans until 2013, when this study was conducted. According to the TAVO Atlas (Mittmann and Schmitt 2001: Map A VIII 3 — Middle East Population Density), by 1978 the eastern Jazira had a settlement density of perhaps 2 to 5 inhabitants per km^2, increasing westward to between 31–100 inhabitants per km^2 in the Khabur Basin. By the mid-1980s, the North Jazira plain had a sprinkling of villages, and in 1995, including the nearby villages of Rabi'ah and Uwaynat, the population of the survey area was approximately 6000 people. World Bank Indicators (2013) suggested Iraq's total population density has increased constantly, reaching 73.1 people per km^2 in 2011, and indications at the time were that the population is still increasing, unlike countries like Syria, whose (pre-conflict) population was decreasing. The rural population made up approximately only one-third of the total population: as in other countries, this has dropped considerably since the 1960s, when 57% of people lived in rural areas. Although there were fewer people there in 2013, rural population growth was increasing far more than urban population growth, putting increased pressure on the limited agricultural land available. In areas such as the Jazira, that land is being used more intensively, reflecting the increasing population density. 2014 however saw heavy fighting in the area, after the so-called 'Islamic State' militants captured the Eski Mosul Dam, leading to heavy fighting to recapture it. In November 2017, BBC news reported that after significant defeats elsewhere, many of the remaining militants fled to the Jazira, where national armed forces pursed them. It remains to be seen what effect the fighting has on the population of the area. Evidence from other conflicts indicates that rural populations, when displaced by conflict, often flee to urban areas, and do not return.[6]

Conclusion

This study has demonstrated that many factors have contributed to the formation and demise of hollow ways in the North Jazira. Building on the geomorphological formation pattern established by Wilkinson et al. (2010), and the route analysis published by de Gruchy (2016; 2017), this paper sought to assess what factors contributed to hollow way formation, and preservation, taking as its start point the fact that physical variables (easiest, fastest, and shortest) did not seem to determine how people moved through the landscape. In addition, we noted that hollow ways formed between settlements that were so close that travellers would have no physical need (such as rest) to stop at each one. Using new methods tested here on three long-distance Ninevite V routes (A, B, and C), it has been possible to consider new theories about why people moved as they did through ancient landscapes and begin to examine the social dimension.

Our results suggest that site size plays a key role: travellers along long-distance routes did not need to seek permission from every local headman (of sites 3 ha and under), but only from chiefs located in centres (>4 ha). This in turn reveals new facets of social organisation: despite a hierarchal social structure, only those of a certain level of importance were perhaps allowed to make decisions about territories, and to grant travel permission. In addition, and perhaps worthy of future research, we noted that several small sites, which would otherwise be unremarkable, were located on these routeways and attained their maximum size during this period, indicating that despite their size they played an active role in the Ninevite V socio-economic network.

In addition, the Thiessen polygon model seemed to tentatively predict the relationship between hollow ways and centres of the Ninevite V Period, suggesting that some of the segments identified belonged to a different period, and that Route C ran along a different path. The model also accurately predicted the location of previously unidentified hollow ways, which were then identified on satellite imagery. Although we could not fully confirm our results due to modern damage in the area, if correct, this would be the first time (barring Wilkinson's excavation) that hollow ways have been tentatively dated by anything other than association with dated sites.

This study has analysed the first of many cultural variables that may have influenced travel, and therefore route formation. In the future, additional cultural variables will be assessed both for this region and beyond, further enhancing our understanding of movement and its relationship to social structures in this period. Recent work by de Gruchy (2017) reassessed Wilkinson and Tucker's (1995) Ninevite V dating using new survey data from the region (Ur 2010), and re-applied nested Thiessen polygons to a larger subset of data. Space constraints mean it is not possible to give the study the attention it deserves here, but two aspects should be noted. The first is that in general our results remain valid, but in addition, the results created a boundary (not located at the survey boundaries) that appears to correlate to two different settlement systems (Figure 9.19). This has important implications for the extent of power during the early 3rd millennium BC, which suggests an earlier date for polities than currently established.

However, it is an inescapable fact that the routes we are analysing are a biased sample. Some hollow ways have been destroyed before they could ever have been documented, as have parts or all of some sites. Of the three routes examined, the best preserved (Route A) had only 68% remaining on the CORONA imagery, and only 58% visible on Google Earth today. Of the worst preserved, only 17% of Route C has survived. By the time Ur recorded the network on the CORONA imagery, almost half was already gone, and today Google Earth suggests that figure has risen, with two-thirds now destroyed, with all due loss of potential information, and the figures are similar (48% preserved, 52% destroyed) for the hollow ways of the North Jazira located in neighbouring Syria (de Gruchy forthcoming). Nonetheless, just as the destruction of sites does not always prevent examination of larger-scale settlement patterns, travel networks can still be inferred, even from fragmentary remains. Still, the incomplete preservation of routes hinders our understanding of the development and use of route networks, as noted in our analysis of the potential path of Route C, where suspected segments can never be confirmed, hindering our understanding of travel and the cultural and socio-economic networks it embodies. Some hollow ways may have continued to be used long after the Ninevite V Period, potentially even through to the present day. For example, the road between Sites 14 and 23 lies precisely where we would expect the find a hollow way that would complete Route B. Unfortunately, the building of the modern road will have destroyed any traces of the hollow way, so the true extent of the route,

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[6] See accounts from Stolac in Hadzimuhamedovic (2015), and from Gernika in Viejo-Rose (2013).

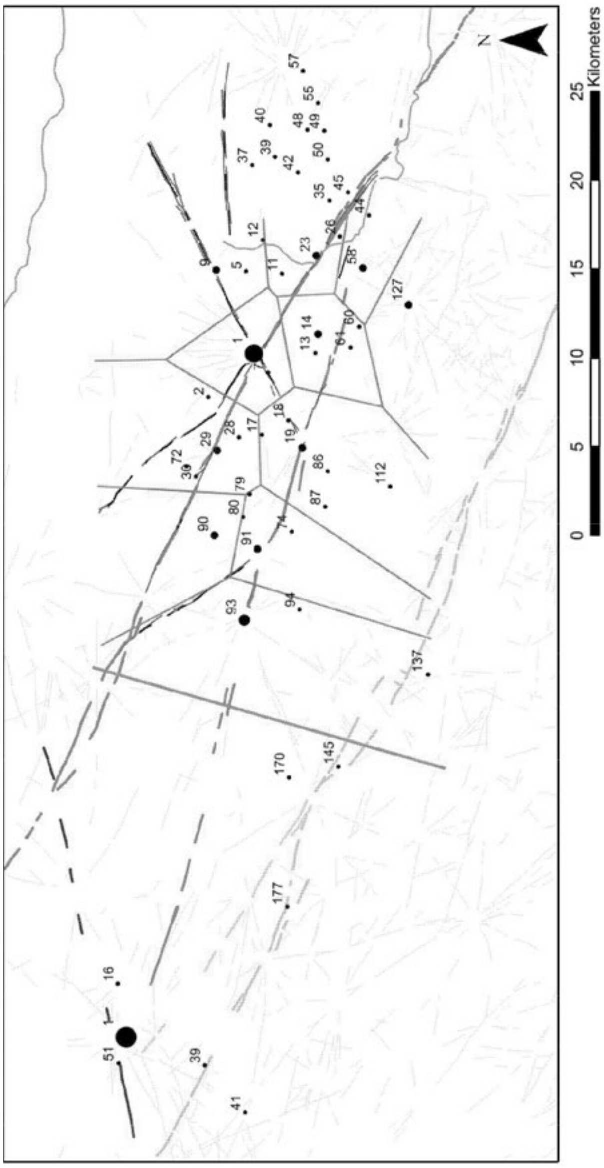

Figure 9.19. A reassessment of the area, including updated periodisation of sites in the North Jazira Survey area and the addition of Ninevite V Period sites from the adjacent Hamoukar Survey, suggests that Tell al-Hawa (the largest site in the right half of the map) and Tell Hamoukar (the largest site in the left half of the map) may have been at the centre of two adjacent polities with differing settlement systems as indicated by the Thiessen polygons in red (figure reproduced from de Gruchy 2017: fig. 9.38).

and the implications for historic travellers, can never be known for certain.

That being said, the levels of preservation over the last 5000 years are remarkable, given that many of the destructive factors examined were present for considerable periods. Yet, it must be remembered that many of the periods when agriculture, for example, was at its peak are the same periods when there were many people who may have continued to frequent these tracks in much the same way as settlements continued to cluster around ancient loci. A review of the routes on CORONA imagery demonstrated that tracks can form quickly, and suggests that some hollow ways were potentially reused in the 1960s, evidenced by a highly reflective surface, appearing only in some seasons. Access to additional CORONA imagery has also demonstrated the presence of new sections of existing routes, and a wider study has the potential to shed further light on these routes. However, the brief re-examination of the CORONA imagery also highlighted that some route segments visible on the 1955 aerial photographs used in the NJS survey were already gone on the CORONA images. The rate of attrition today is considerably higher.

There is no discernable reason why some route segments have survived whilst others are lost. Original size/depth are almost certainly factors, although none of the reviewed routes were considered ‘broad’, which would indicate a relationship to greater use. Hollow ways between sites that were the most frequently occupied (theoretically then leading to greater use, deepening the hollow ways more) were in fact the most poorly preserved. Many of the routes deep enough to have been visible on contour maps are those that survive best today, yet others left no such obviously deep trace but can still be seen (for example, the segment between Sites 93 and 91). Water erosion plays a part in deepening hollow ways, contributing to survival, but it is not the sole, or even main, factor: that accolade goes to human endeavor. Increasing agriculture, the irrigation programme that necessitated the original rescue survey, urban development and the creation of modern roads, all supported by bulldozing, have all played a part. Although population pressure poses a serious threat to sites and to the more fragile off-site remains, such as hollow ways, we stress that the needs of the modern population, particularly in light of the devastating conflict, must come first, but hope that management planning may offset any necessary damage.

Offering some slight hope, seasonality clearly also plays a factor: some features are clearer due to the increased moisture levels on the October 2010 DigitalGlobe, which covers only a small part of the survey area, so additional hollow way sections may yet remain. Additionally, subsurface remote sensing techniques continue to develop (for example, Casana 2014), which could identify hollow ways that have been plowed level to the surrounding landscape but still have an underground profile. It is tempting to suggest that this study be repeated as more and better imagery becomes available, but with each year that passes, the likelihood is that more will be lost. It is for this reason that we are grateful for the information available to us from the study of older aerial photographs, satellite images, and historic maps, which provide windows into the landscape before the intensive modernisation and ensuing destruction we see today.

Acknowedgments

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Hollow Ways in Southern Mesopotamia

Elizabeth C. Stone

Although hollow ways are common features of the archaeological landscapes of both Europe and the Middle East, it was Tony Wilkinson, as part of his North Jazira Survey (Wilkinson, 1993; Wilkinson and Tucker 1995), who brought them to the broader attention of the Near Eastern archaeological community, and it was this work which inspired his student Jason Ur to expand the area of investigation to the entire Jazira area of the Middle East (Ur 2003). For Wilkinson, with his background in British landscape archaeology, the shorter, deeper hollow ways of Britain and their longer, somewhat wider cousins, the drover's roads, would have been familiar elements of his native countryside. Below, I will use data on the British tracks to better understand similarities and differences between two different examples of hollow ways in the Near East. The first are those popularised by Wilkinson and Ur: broad shallow pathways which lead out in all directions from Bronze Age settlements in northern Iraq and northeastern Syria, some extending to link neighbouring settlements. The second, the focus of this paper, are somewhat similar radiating tracks seen in satellite imagery (Figure 10.1) within a single area of southern Iraq to the northwest of the ancient city of Borsippa (Figures 10.2 and 10.3). Key issues for discussion, none of which can be proven, are the reasons behind the movement along these routes, what caused them to be etched into the countryside, and what they can tell us about developing Mesopotamian lifestyles.

Drover's roads and hollow ways in Britain

The ancient trackways of Britain come in two forms: hollow ways — also known as sunken lanes or holloways — and drover's roads, though the latter term is sometimes also applied to the former. Both are still significant features of the modern landscape. Hollow ways are narrow, usually only 1–2 metres wide, and are generally understood to have been used primarily for local journeys (Davies 2006: 22). Drover's roads, on the other hand, were the main routes along which herd animals were moved from the countryside to the cities for slaughter, especially to London, and might be as much as 20–30 metres wide (Hindle 2001: 68; Taylor 1979: 168). In one instance, for example, a 30-metre wide culvert was built over a small stream to ensure that the flow of animals was not slowed (Taylor 1979: 168). These larger routes would have been fed by smaller ones, ranging in size down to the narrow hollow ways used for local travel. Much about these tracks remains mysterious including their date and purpose, though many argue that they provided the routes between villages to hills for grazing or surrounding fields (Hindle 1998: 46–47). While today some lie along roads within agricultural areas, others are to be found in uplands which remain unfenced, so it seems unlikely that they are the result of enclosure — indeed most are thought to have greater antiquity. Yet I find the literature to be remarkably vague as to the actual mechanisms behind the creation of these, often deep, depressions. Most discuss traffic, with perhaps an emphasis on wheeled vehicles, although Crawford (1953: 61) stresses the significant contribution of animals. The key question here is what *was* the major source of traffic on these roads? My suggestion is that it was the daily movement of animals between grazing areas and milking parlours that would have been the most active force in the creation of these hollow ways.

Any walker through the English countryside will be aware that shaded paths, even in summer, are likely to be muddy, as are gateways between fields holding cattle, but not sheep. Cow hooves are 4–5 times larger than those of sheep, but cattle are eight to nine times heavier and are therefore likely to sink deeper into muddy areas. All of the historical data from Britain indicate the dominance of cattle. Two cows to every sheep travelled along the major drove ways — more if you omit Wales (Styles 2006: 63). Moreover, after the 13th century there is evidence that as sheep became specialised for wool, dairy cattle became increasingly important (Woolgar 2006: 94–95). The narrow hollow ways were thus likely created by cattle, a species which instinctively follows a leader in a linear fashion (Albright and Arrave 1997: 52–53), as they travelled twice daily between grazing areas and dairy.

Hollow ways in Syria

Like the hollow ways found in Britain, those in the Jazira are understood to have been routes between settlements and the grazing areas beyond the cultivated zone, as well as between neighbouring towns (Ur 2009; Wilkinson 1993; Wilkinson and Tucker 1995). But unlike the British examples, these hollow ways are remarkably

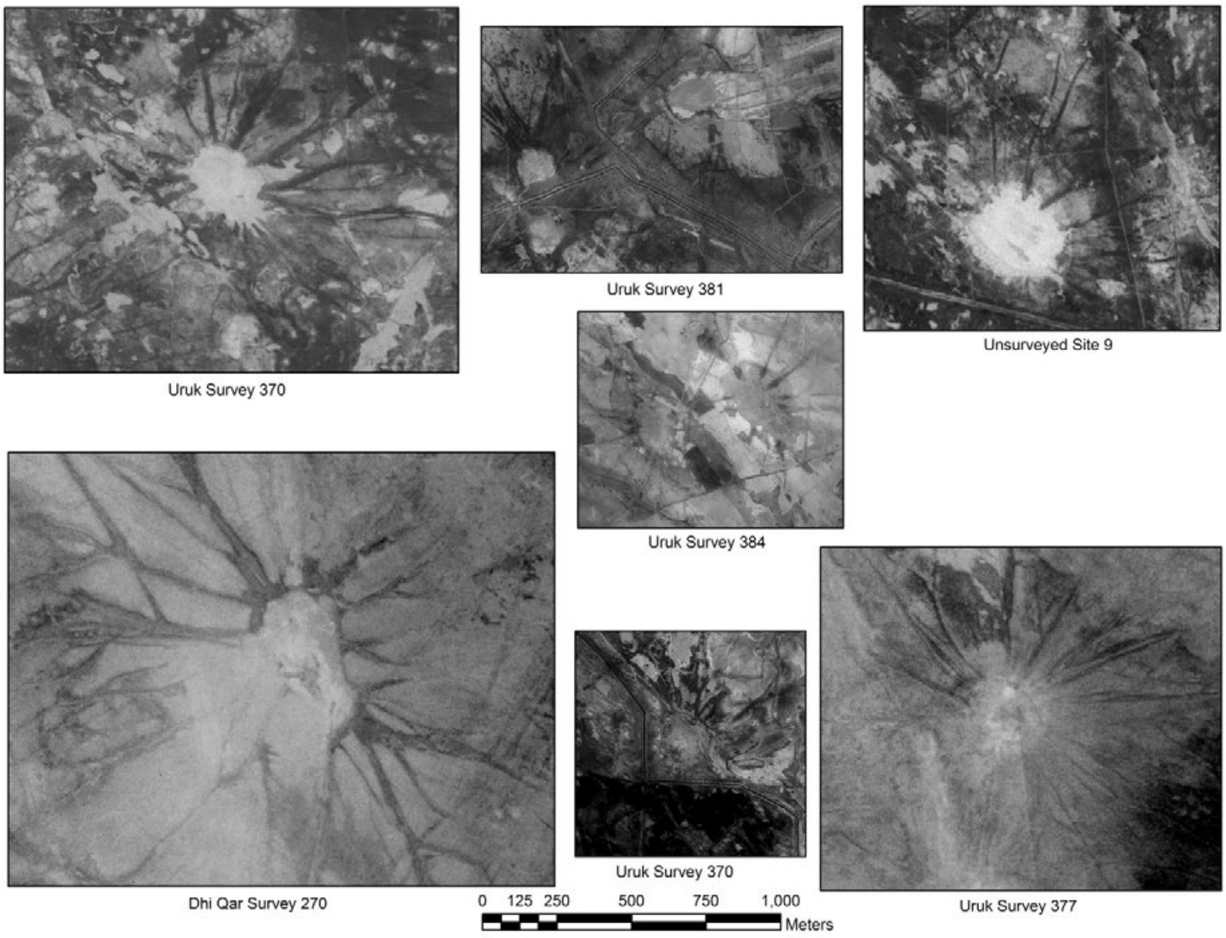

Figure 10.1. Images of sites with radiating lines: Uruk Survey 370: CORONA DS1103-1041df051; Uruk Survey 381: Digital Globe Quickbird image 1010010001A89200; Unsurveyed Site 9: CORONA DS1103-1041df051; Uruk Survey 384: Digital Globe Quickbird image 1010010001A89200; Dhi Qar Survey 270: CORONA DS1103-1041da057; Uruk Survey 370: Digital Globe Quickbird image 1010010001A89200; Uruk Survey 377: CORONA DS1103-1041da58.

wide, between 60 and 100 metres. They are much older than the British examples, relics of a lifestyle that was abandoned more than four millennia ago.

The data suggest that the hollow ways in the Jazira area of Iraq and Syria were also the result of the daily passage of animals between grazing areas and milking parlour, but in this instance the animals in question were sheep and goats rather than cows. This interpretation is, I would argue, confirmed by their morphology. It should not be surprising, given the differences in rainfall and their great age, that these pathways are shallower than those in Britain — generally little more than one metre (Wilkinson *et al.* 2010), but they are much broader than the British examples (Ur 2009). This only makes sense if the animals being moved were sheep. Unlike cattle, sheep are flocking animals and move in a bunch rather than in a line: Indeed, the woolier the sheep the stronger the flocking instinct. Essentially every sheep aims to stay safe by being surrounded by other sheep (Lynch *et al.* 1992: 81–82) even when moving from place to place.

Another consideration is the plethora of hollow ways surrounding each site. If we take 80 metres as the average width, and apply this to the 15 hollow ways[1] in the area surrounding Tell Mansur in the Syrian Jazira (a nine hectare site with a well-preserved ring of hollow ways), the area assumed to have been used for agriculture — that between the edge of the site itself and the end of the local hollow ways — would have been diminished by one tenth in order to accommodate this traffic.[2] Such a cost would surely only have been worthwhile when the herds travelled on such a regular basis that they needed to be routed directly to the available pasture without expending excessive energy

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[1] For those hollow ways that connected Tell Mansur with neighbouring settlements, we measured only the length that was commensurate with the shorter hollow ways on each side.

[2] This assumes that all hollow ways were used at the same time.

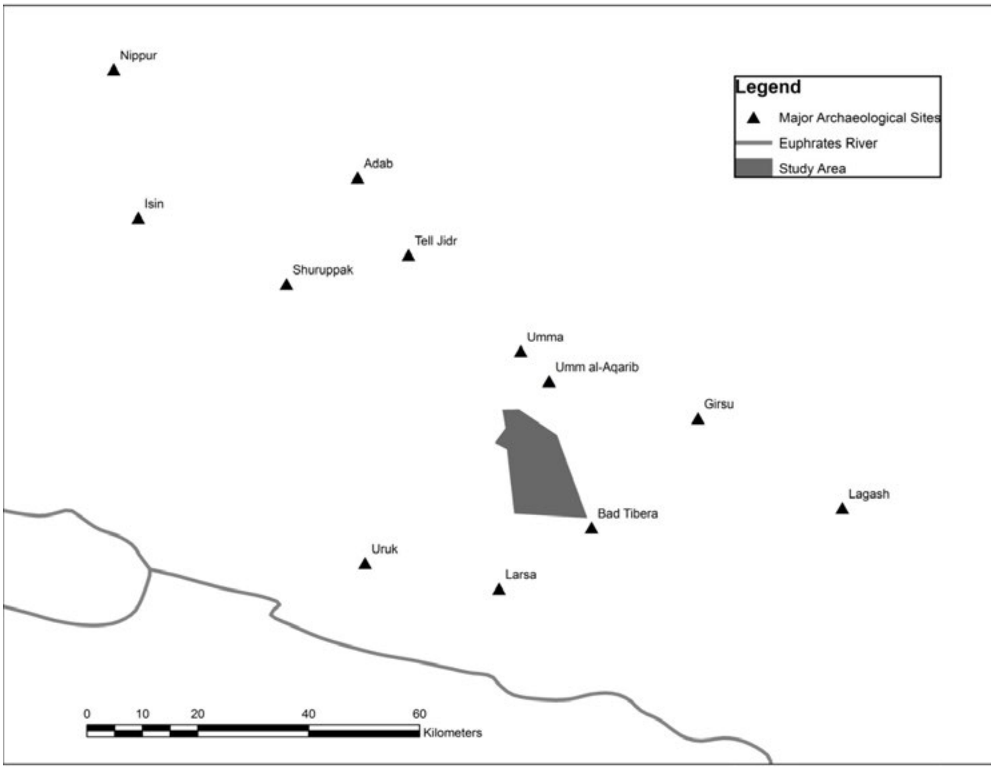

Figure 10.2. Map showing the location of the study area.

accessing areas not immediately at the end of the tracks. Unless there was a severe lack of security, the only reason for this daily movement would be to enable to milk the animals on a daily basis. Although today it is common to see sheep in the Middle East milked within their pastures, this is only made possible by modern milk containers and tractors to transport them back to the villages. These were not options in the past.

The importance of sheep is made clear from both the textual and especially the faunal data from northern Syria. Animal bones from excavations in the archaeological sites of Tell Beydar (Siracusano 2013: 273; Van Neer and Ducupere 2000: 98–99), Tell Bderi (Becker 1988: 382), Tell Brak (Clutton-Brock *et al.* 2001: 349; Dobney *et al.* 2004: 418; Emberling *et al.* 1999: 28), Tell Chuera (Boessneck 1988: 82), and Karana 3 (Boessneck *et al.* 1993: 235) document a heavy emphasis on sheep and goats over cattle. Based on NISPs, the ratios ranged from five sheep to every cow at Tell Beydar to as high as 17 sheep at Tell Karana 3. Moreover, the analysts of the fauna from Tells Beydar and Brak use the age profiles of the sheep and goats to suggest a focus on milk and wool (Dobney *et al.* 2004: 419; Siracusano 2013: 285; Van Neer and Ducupere 2000: 79). Texts from Tell Beydar (Vanleberghe 1996: 97) indicate a strong emphasis on woollen textiles, though they provide no information on the importance of milk.

The conclusion that I want to draw here is that the very different morphology of the hollow ways in Britain and the Jazira cannot be understood to be solely the result of differences in climate and history. While the continued use of the British hollow ways and the long-term abandonment of those in the Jazira have resulted in significant differences in their erosional history, the differences in the profiles of the two suggest that they were created by different but related processes. I suggest that these differences lie in what species of animal was being exploited for milk and commuted on a daily basis between village and pasture for this reason. Broad, fairly shallow roadways, like those in the Jazira, are thus interpreted as the result of the movement of herds of sheep in and out of town on a daily basis, whereas similar movements of cattle result in deeper, narrower pathways, like those found in Britain.

Southern Iraq

We do not expect to find similar traces associated with southern Mesopotamian sites. The few faunal studies combined with the written and art historical data suggest that cattle were rare for much of Mesopotamia's history, with the exception of the earliest periods, while the grazing areas for sheep would have been distant from the irrigated surroundings of the towns and cities. We also need to distinguish between those

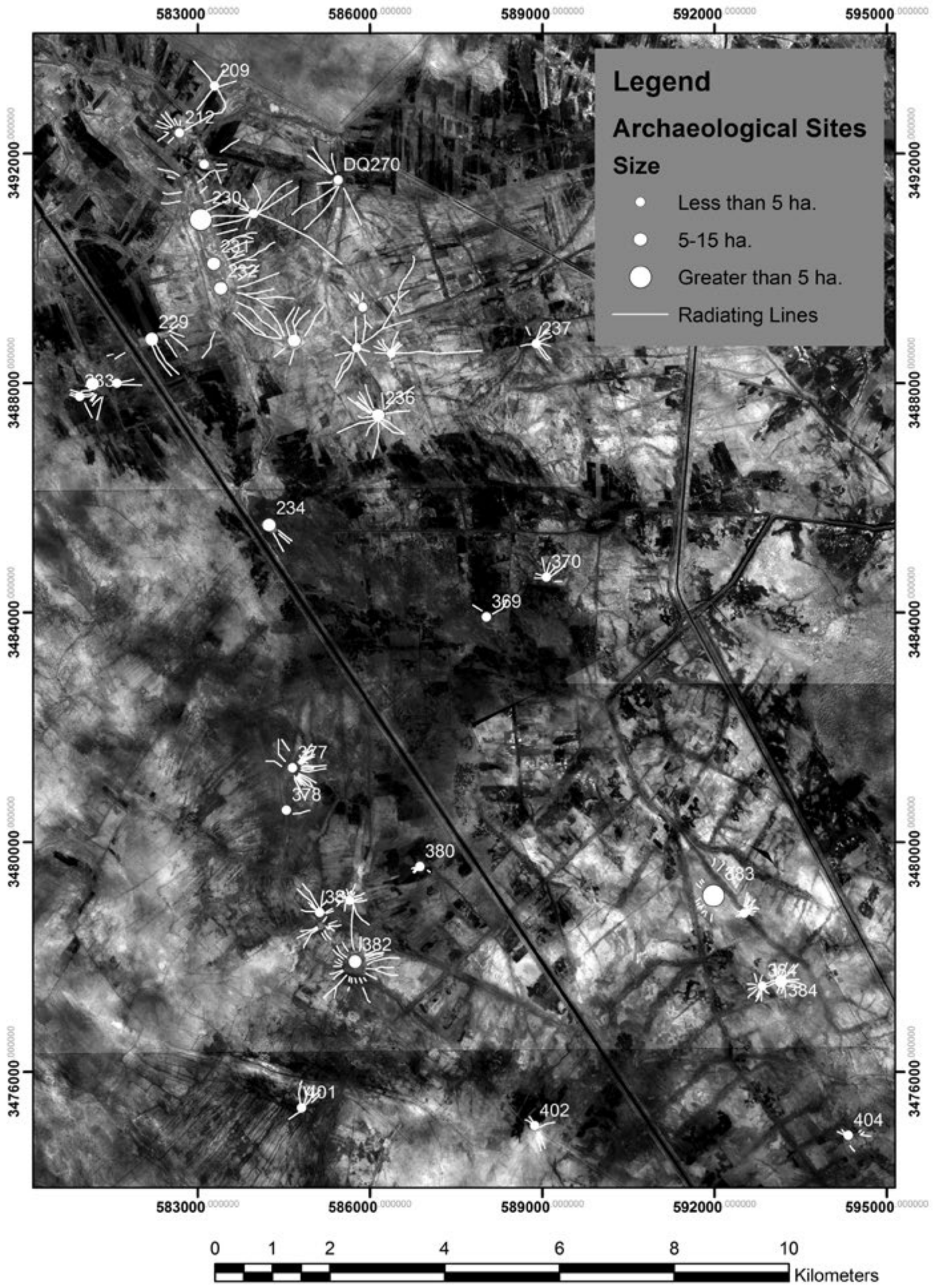

Figure 10.3. Map of southern Mesopotamian sites with hollow ways. (Site numbers are from Adams and Nissen, 1972; DQ site numbers are from the Dhi Qar Survey conducted by Abdel-Amir Hamdani.) Imagery courtesy of the Digital Globe Corporation. Images were captured between February 17 and 22, 2003.

animals recorded in texts because of their importance to the state which was interested in secondary products — milk products from cattle and wool from sheep — and those used for private consumption, such as pigs, an animal whose bones are frequent in archaeological assemblages despite their near absence from the written record. Although the analysis of faunal data from Mesopotamian sites is rather slim — at least in part due to the looting of dig houses following the Iraqi invasion of Kuwait — the combination of textual information and such faunal analyses that do exist suggest shifts in animal husbandry over time. Neolithic fauna from Tell el-Ouelli indicate an emphasis on cattle and pig (Desse 1983; 1987; 1996). However, the faunal assemblages from the small sites of the Uruk Mound at Abu Salabikh (Pollock 1990: 87–88) and the Early Dynastic I site of Sugheri Seghir (Bökönyi and Flannery 1969; Wright 1969), were dominated by sheep and goats. By contrast, the early texts suggest that cattle may have been the dominant species at Uruk during the earliest phases of Mesopotamian civilisation and through the pre-Sargonic at Lagash, but by Ur III times, these had been largely replaced by sheep (Englund 1995). For later periods, only the texts associated with the rather mysterious Sealand Dynasty suggest that beef was an important source of food, even as sheep retained their importance as sacrificial animals (Dalley 2009). We spent a brief season of excavations at Tell Sakhariya in 2011–12, a smallish site near Ur. The ceramics from most of our trenches are similar to early Kassite examples, perhaps even very late Old Babylonian, known otherwise only from sites in northern Babylonia. The data from Sakhariya are consistent with the time and place associated with the Sealand Dynasty and its levels yielded a surprisingly high percentages of cattle bones (Kathryn Twiss, pers. comm.), though sheep and goat were still the most common animals. Pigs, fish, and the shells of fresh-water molluscs were also present. The lack of permanent architecture suggested a temporary occupation, and the absence of any bird bones perhaps indicate that this occupation occurred during the annual summer regrowth of the reed beds in the marshes.

The very small number of cattle bones in all other Mesopotamian faunal collections, together with their maturity, has always suggested that these animals were kept not so much for meat or milk but for labour, used to pull plows and to tow boats. Therefore at most Mesopotamian sites, any milk or cheese would have been derived from sheep and goats, rather than cattle, though there is little evidence, beyond analogies used in Sumerian love poetry, of milk products playing an important role in the Mesopotamian diet.

Hollow ways in southern Iraq

Although rare, hollow ways associated with ancient settlements can also be seen in some high resolution CORONA and Quickbird imagery from southern Iraq. In an area of 164 square kilometres between Bad Tibera and Tell al-ʿAjjul, 37 of a total of 40 archaeological sites are surrounded by between three to twenty-four radiating lines (Figures 10.1 and 10.3; Table 10.1), a few of which are extended to link neighbouring settlements. Of these, 27 sites were visited as part of the Uruk Survey (Adams and Nissen 1972), all but one[3] of which is recorded as having been occupied between Late Uruk and Early Dynastic 1 times, although some also have later occupations dating to between the Neo-Babylonian to Sasanian Periods.[4] Two sites in the area were included in the Dhi Qar Survey and recorded as having an Early Dynastic occupation, though without further designation (Abdelamir Hamdani, pers. comm.). Only three sites have evidence of settlement in the 1st millennium BC, none of which have radiating lines. I suspect that there is one other group of sites with radiating lines, Uruk Survey 381, recorded with only a Sasanian occupation but likely to have had smaller, early occupations that were not picked up on survey. Indeed, this is suggested by a difference in their hollow ways. In sites with only early occupations, these begin within the edges of the site itself, but in this instance, and in the case of some other sites with later occupations, they are first visible beyond the edge of the site (Figure 10.1, compare Uruk Survey 370 and 384 with Uruk Survey 381). This would be expected if larger, later mounds covered the earlier settlements that were contemporary with the hollow ways, and is characteristic of many of the sites with later occupations. The three in question have a total of 26 radiating lines, one of which links it to Uruk Survey Site 382 which, in addition to evidence for a late occupation in Neo-Babylonian and Achaemenid (but not Sasanian) times, also had Jemdet-Nasr and Early Dynastic 1 surface sherds. An additional nine sites were not picked up by the survey but are visible in the imagery and similarly surrounded by radiating lines (Figure 10.1, Unsurveyed Site 9). Although their dates are unknown, it seems not unreasonable to suggest that they, like the surveyed sites, were also occupied between Late Uruk and Early Dynastic 1.

A striking feature of this area is that it was only briefly settled, and was apparently unoccupied between Early Dynastic II and Neo-Babylonian/Achaemenid times, although the two sites from the Dhi Qar Survey are also recorded as having Old Babylonian pottery, though this may well be the result of over classification of Old Babylonian sites in this survey.[5] Only 11 sites were occupied between Neo-Babylonian and Parthian times with only 11 occupied after that time, three of which were new settlements. This area was partly flooded when the CORONA imagery was taken, and today it continues to have a high, but variable, water table, perhaps suggesting that the area is a natural basin. Unfortunately the SRTM imagery is rather inconsistent in this area, with neighbouring pixels frequently recorded as varying in elevation by 10 or more metres.

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[3] The group of three mounds in question, Uruk Survey 381, is recorded as only occupied in Sasanian times, but I suspect that it had a smaller, early occupation that was not picked up on survey. Between them they have a fine group of 34 radiating lines, one of which links it to Site 382 which, in addition to evidence for a late occupation in Neo-Babylonian and Achaemenid times, also had Jemdet-Nasr and Early Dynastic 1 surface sherds.

[4] Two sites were only recorded during the Dhi Qar Survey, carried out by Abdelamir Hamdani following the 2003 war and designed primarily to assess the condition of the sites.

[5] These are recorded as both Early Dynastic and Old Babylonian. However, fully two thirds of the Dhi Qar sites were also recorded with the Old Babylonian occupation, whereas only 21% of the sites in the Uruk Survey are recorded as having Ur III/Isin-Larsa or Old Babylonian sherds. This suggests that there was a strong over-representation of the Old Babylonian designation in the Dhi Qar record.

Table 10.1. Sites with radiating lines.

Survey	**ID**	**Area (ha)**	**Height**	**Early Date**	**Late Date**	**# Radiating Lines**	**Mean length (m)**
Dhi Qar	270	1.4	?	ED	OB?	22	399
Dhi Qar	307	3.6	0.0	ED	OB?	7	530
New Site	6	2.1				12	139
New Site	5	3.7				9	149
New Site	1	1.4				4	152
New Site	8	3.9				4	242
New Site	9	1.2				18	282
New Site	2	0.5				11	323
New Site	7	2.7				14	411
New Site	3	0.5				13	496
New Site	4	0.4				10	538
Uruk	380	0.1	2.1	JN	PAR	10	79
Uruk	383	18.9	2.8	JN	ED1	13	105
Uruk	404	1.6	2.6	JN	ED1	18	113
Uruk	233a	11.6	2.1	JN	ED1	7	132
Uruk	384	10.0	1.9	JN	ED1	14	144
Uruk	232	10.9	1.7	JN	ED1	13	182
Uruk	402	1.9	2.1	Uruk	NB	14	199
Uruk	384	2.5	?	JN	ED1	12	202
Uruk	381	15.0	2.2	?	SAS	15	207
Uruk	381	1.6	2.1	?	SAS	10	210
Uruk	381	4.6	2.2	?	SAS	9	235
Uruk	237	1.0	2.0	LU		17	235
Uruk	233b	1.7	0.0	JN	ED1	6	241
Uruk	234	5.9	0.6	LU	JN	5	252
Uruk	212	3.5	2.0	JN	ED1	10	257
Uruk	401	0.9	1.0	JN	NB	15	270
Uruk	377	2.5	2.0	JN	ED1	32	286
Uruk	369	3.4	1.9	JN		16	300
Uruk	382	1.8	4.0	ED1	NB	23	305
Uruk	230	26.5	2.6	JN	ED1	12	310
Uruk	370	2.5	1.8	JN	NB	23	319
Uruk	209	0.6	0.8	LU	PAR	5	382
Uruk	231	12.5	1.7	JN	ED1	21	401
Uruk	229	9.3	2.0	JN	SAS	26	409
Uruk	378	0.4	0.8	JN	ED1	11	417
Uruk	236	5.7	0.2	LU	LU	14	442

Only the wetness of the ground in an area with little modern irrigation suggests a lower elevation. It is largely thanks to the high water table in this area that these radiating lines, 495 of them, are largely visible due to their slightly increased depth (see Table 10.1). They tend to be visible as wet areas passing through dryer ground and are generally broader closest to the tells, and narrower further away. In dryer areas they tend to be light in colour, and manifest as clear areas with vegetation on either side. I interpret their wetness as an indication of their hollowness, but without visiting the area, this cannot be directly confirmed. Compared to the hollow ways in the Jazira, they are quite small, with an average width of only 13 metres, though they range from 2 to 46 metres. They are also quite short, from as little as 79 to more than 500 metres long, with a mean of only 300 metres. The longer traces tend to be located in the northwestern part of the area and the shorter in the southeast. These differences between north and south are more a reflection of slight differences in the water tables when both the Digital Globe and CORONA imagery were acquired, and which affect the visibility of these traces in different parts of the imagery, especially the shallower tails of these lines.

If we compare these lines with the hollow ways of Britain and the Jazira in terms of both length[6] and width, they are more comparable to the British examples than to those in Syria, especially if one were to measure the tops of the British hollow ways rather than their bottoms.[7] Like the hollow ways in Britain and the Jazira, the most likely explanation is that it was travel by humans and especially animals on a very regular, probably daily, basis that has resulted in these slight depressions, making them visibly wetter in this area of high water table. The similarities in their morphology to the British examples suggest that the animals involved were likely to have been cattle rather than sheep and goats. The narrow period of occupation of the sites[8] surrounded by these features also suggests that this was an activity that was important in the earlier part of Mesopotamia's history, but not in later times. Uruk III textual data, contemporary with the sites with radiating lines, indicate the importance of milk products derived from cattle. They document a very heavy emphasis on the acquisition of milk fats, essentially ghee, by the administration of Uruk (Englund 1995: 33–40). Englund also stresses the very real difference between that emphasis on milk products and its very rare appearance the later, very well documented, Ur III Period. Indeed, the Uruk administration apparently extracted so much ghee from the cattle herds that only the milk needed to feed the calves could have been consumed locally, with all the remainder sent to the city.

Today, of course, cattle are rare in southern Iraq, and both the written and archaeological records suggest that this was the case in later periods of Mesopotamian history. The one place where they are encountered now is in the marshes, where the plentiful reeds provide good nutrition over the spring and summer and can also be stored for feed over the winter (Figure 10.4). Jennifer Pournelle (2007) has argued that Mesopotamian civilisation originated in a much wetter world than is the situation in southern Iraq today. She has marshalled a significant body of evidence which suggests that sea levels were considerably higher in the Uruk Period and marshes much more abundant. Indeed, she sees the birth of Mesopotamian civilisation as not so much the result of the development of irrigation systems, but from exploiting the rich potential of its wetlands, with settlements located on patches of higher ground. The backslopes of these 'turtlebacks' could have been used for date and grain cultivation, while the marshes would have provided a good environment for cattle and pig. Pigs, of course, provide only meat, but cows are the most efficient milk producers in the animal world. Since our sites with the radiating lines (Figure 10.2) are exactly contemporary with this early, wetter landscape, I suggest that the pattern of radiating lines reflects the daily travel of cattle into the marshes for fodder and back to the settlement in the evening to be milked.

The one urban centre in the area, Umm al-'Ajjaj (Uruk Survey 230–232), has three mounds which together form a long, narrow 83 hectare urban centre, located on one of Pournelle's turtlebacks. To its north and west is an area of higher ground, as recorded in SRTM imagery, and no sites with radiating lines are to be found there. Indeed, the majority of its radiating lines are to the south and east, suggesting that it was its access to *both* wetlands and cultivatable areas that made its urban development possible. It is located to the northwest of the area under consideration here, most likely with an irrigable area of arable land to its west and the marsh to its northeast, south and east and thus in a strategic juxtaposition between cultivable land and wetlands. Although the entire site was large, its radiating lines are relatively short, perhaps an indication of a more mixed agricultural and pastoral economy. SRTM imagery, though it lacks the accuracy needed to fully understand the slight differences in topography in the extremely flat Mesopotamian plain, nevertheless indicates that the all the sites with radiating lines were located towards the edge of a basin. In the CORONA imagery,

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[6] I have, however, been unable to find any statistical data on British hollow ways.

[7] The location of measurement is clearly important. Since many of the British hollow ways are still used as roads and tracks, they are usually perceived from the bottom. By contrast the hollow ways in Syria and Iraq are known primarily from satellite imagery and are therefore seen from the top. When identified through Google Earth, British hollow ways are often around 6–8 metres in width.

[8] Although some had later periods of occupation in addition to the Uruk to Early Dynastic I levels, as noted above, all (except one) are recorded as being occupied during one or more those three early time periods.

Figure 10.4. Cattle feeding on reeds: (Left) in the marshes (Right) beside a salt-water drain.

acquired in May 1968, this area was at the edge of a marsh that stretched to the east beyond Girsu. The sites in the northern and western part of the area considered here have the longest and the most numerous traces, perhaps an indication that then too, water was shallower in this area. Uruk Survey (Adams and Nissen 1972) sites 377 to 382 have shorter radiating tracks than those in the northern part of this area, but are often more extensive than those in the areas to the south and east, an area which would have been slightly lower if the wet area seen in the CORONA imagery can be used as an indication of surface elevations back in the 3rd millennium. But given the five millennia between the ancient landscape and today, it is likely that the modern topography only partially reflects what might have been the situation when these sites were occupied.

The importance of this area is made clear by the density of sites. If you compare this area with the entire Uruk and Nippur Survey areas, sites dating between the Uruk and Early Dynastic I Periods are more than six times as frequent here than in the survey area as a whole. The morphology of the lines can only be interpreted as a result of the movement of animals in and out of the settlements, and the low-lying aspect of this area suggests that it was the location of an ancient marsh. If so, this would have been inimical for sheep and goats. Moreover, pigs have no secondary products that would make it desirable to move them often between site and foraging area, so they are not likely to have been responsible for the tracks. But cattle are prime milk producers requiring their daily return to the settlement, have generated hollow ways similar in scale in Britain, thrive in wetlands as attested by their importance to modern marsh dwellers, and are well attested in the contemporary texts.

These data have implications for the history of Mesopotamian settlements. Unfortunately, as we saw earlier, the recovery of architectural data from residential areas dating between theLate Uruk and Early Dynastic I are few and far between, but where these data are available, they evidence low density structures, with sufficient open space between them to house large domestic animals. The importance of cattle in these early periods is also reflected in the texts, but the very limited faunal evidence indicates that sheep were the animal of choice at the rare sites where these data have been collected. And for most of Mesopotamia's urban history, it was sheep, not cattle, which were the most important, a situation reflected in both the written record and the faunal assemblages.

I would like to suggest that as the climate became more arid during the 3rd millennium BC, environments that had been conducive to the keeping of cattle would have been reduced in favour of those best for rearing sheep and goats. Whereas cattle are grazing animals that can thrive in wetland environments otherwise incompatible with agriculture, sheep can thrive in the steppe. While cattle, sheep, and goats all produce meat and milk, sheep are also a source of the raw material for textiles, which were the key to Mesopotamia's ability to trade for the raw materials — metals, stone, timber, etc. — that were in such short supply locally. Thus the shift in importance from cattle to sheep must have been the result of both environmental and economic forces. This shift was crucial for the development of Mesopotamian cities. As long as cattle were important, they would have been associated with low-density settlements, like the West Mound at Abu Salabikh (Postgate 1983), which had the space necessary to allow domestic animals to be brought in at night to be milked. But the aridification of the area that led to the reduction in the marshes by the late Early Dynastic greatly limited the sustaining area for keeping cattle and, as a result, sheep would have replaced cattle as the main source of meat. These animals were grazed at increasing distances from the settlements as their use as a source of milk was replaced by the importance of wool for textiles. It was therefore these changes in animal management — especially the decrease in importance of milk in the diet — that allowed the growth of large, dense urban centres that became the focus of civilised life. The wetlands which remained continued to be important sources of fish and water-birds, and it seems likely that this would have been a good environment for domestic pigs, but they ceased to be the focus of settlement, and the radiating lines indicating animal movement in out of settlements ceased to be a part of the southern Mesopotamian landscape.

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Remote Sensing-Based Approaches to Site Morphology and Historical Geography in the Northern Fertile Crescent

Jesse Casana

Introduction

To an earlier generation of Near Eastern archaeologists, regional survey was only useful as a means to find a place to excavate. Even Robert Braidwood's (1937) survey of the Plain of Antioch, while often cited as the first systematic survey in the Near East, is explicitly offered as a guide to future excavations.[1] By the 1960s, however, the pioneering work of Robert McC. Adams (1965) and others had demonstrated the unique value of more systematic regional survey to reveal things that excavation simply could not: the distribution of settlement across environmental zones, changes in past population levels, and the relative size of sites as a window in social and political hierarchies. By showing the multifaceted value of landscape based approaches to the archaeology of the Near East as a whole, Tony Wilkinson's (2003) landmark book, *Archaeological Landscapes of the Near East*, transformed regional approaches into a central pillar of the field, with their value widely recognised as independent of, and complementary to, excavation.

Ironically, however, even many acolytes of 'Wilkinsonian' regional archaeology remain skeptical of remote sensing-based investigations that do not directly incorporate field survey. Satellite and aerial remote sensing are often seen as something archeologists do primarily in service of potential fieldwork. Remote sensing is understood as valuable only insofar as it helps us find sites to survey, in the same way that survey itself was once understood as valuable only insofar as it helps us find sites to excavate. This paper seeks to illustrate some ways in which satellite remote sensing can serve as an arena of archaeological inquiry in which we can make substantive discoveries independent of 'boots-on-the-ground' archaeology, something that is of particular value in this era of diminishing field opportunities in the Near East (Casana 2013a).

Herein I present interim results of a regional scale, remote sensing-based survey of the Northern Fertile Crescent. By undertaking a systematic, comparative analysis of more than 15,000 sites located in a study area extending from the Mediterranean coast to the mountains of Northern Iraq (Figure 11.1), it is proving possible to recognise trends in the distribution of settlement across this vast region and to identify commonalities in site morphology that are distinctive of particular times, regions, and cultures. In much the same manner that archaeologists are able to estimate the date of artifacts based on their style, this paper explores how morphological analysis of sites can similarly be used to estimate their date.

The approach described here is also a powerful mechanism to recognise unique and potentially significant sites, and thus can aid in identifying candidates for historically known but as yet unidentified cities, as well as for reconstructing the broader historical geography of the region. Following an overview of methods for identification of sites on satellite imagery and the creation of a morphological taxonomy, I illustrate regional distributions of several common site types as well as several unique sites with arguments for potential toponymic identification.

Satellite imagery based archaeological prospection

Few scholars fully appreciate how incomplete and uneven our knowledge of site distribution in the Near East actually is, even in relatively intensively explored regions. In the Upper Khabur Basin for example (Figure 11.2), where much of Wilkinson's research was focused, early surveys such as that by Mallowan (1936) recorded only the most prominent mounds, while others concentrated on sites of specific types (e.g., Davidson and McKerrell 1976). Later surveys, such as that around Tell Leilan (Ristvet 2005; Ristvet and Weiss 2013), found higher site densities but nonetheless produced strong bias towards the recording of more easily visible mounded sites. The most intensive survey projects, undertaken either by Tony Wilkinson or his students, including those in the Iraqi North Jazira (Wilkinson and Tucker 1995), around Tell Brak (Wright *et al.* 2007), Tell Beydar (Ur and Wilkinson 2008), and Hamoukar (Ur 2010a), produce the highest site densities (Figure 11.2A). Differences in site density suggest that even within some areas that have already been investigated,

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[1] Following an explanation of how mounds can be dated through analysis of surface artifacts, Braidwood explains: 'Hence we can present here not only the names of all the mounds in the Plain of Antioch, with their positions fixed on maps, but also indications of the various cultural periods during which they were occupied and of the distribution of remains in each period. In our mound list and maps the archaeologist interested in the excavation of a site in this part of the Near East may, we hope, find information to his [sic] advantage...' (Braidwood 1937: 1).

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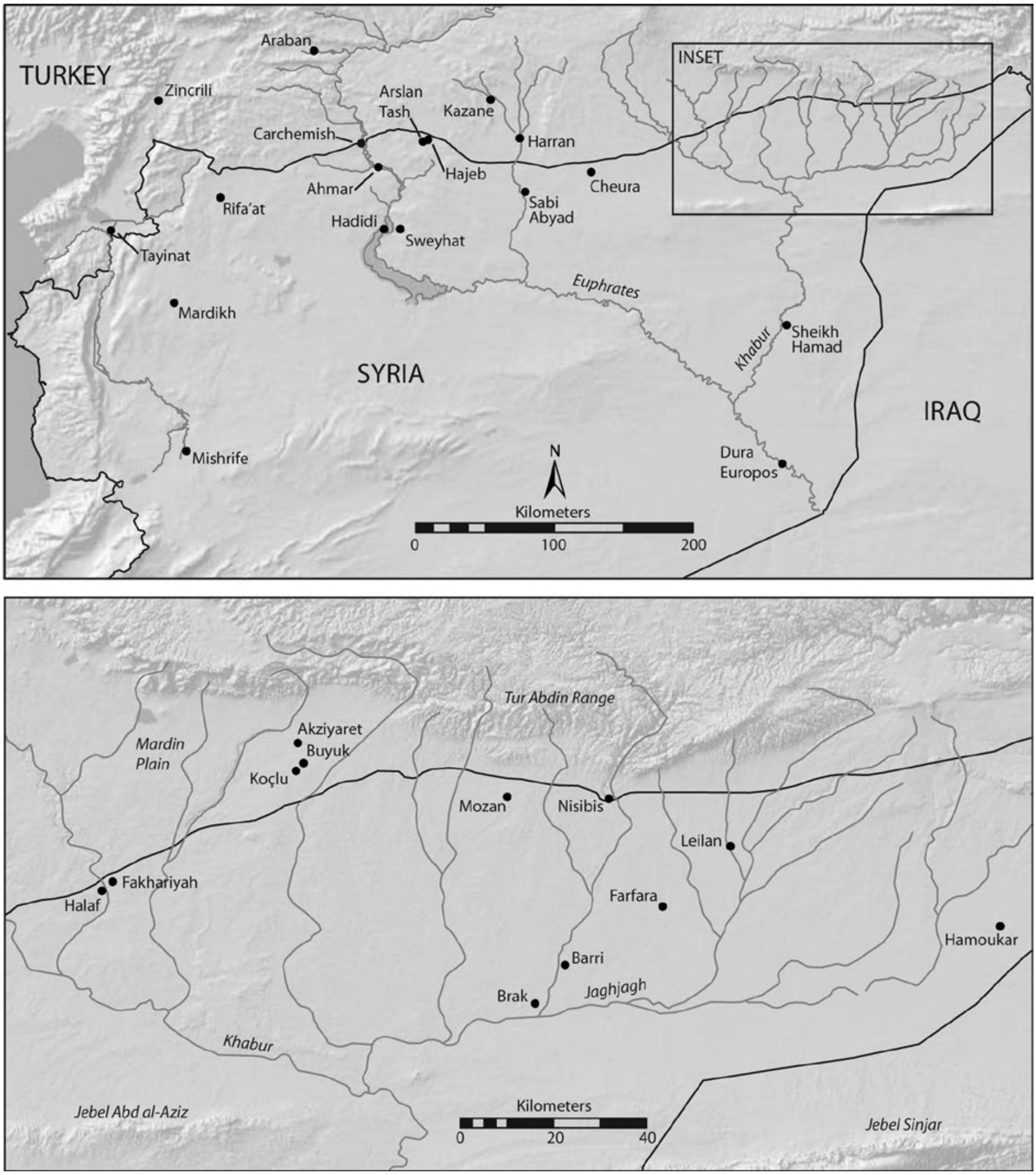

Figure 11.1. Location map illustrating the study and key sites discussed in the text.

many sites have yet to be discovered. Meanwhile, all areas outside the boundaries of these survey projects, such as the plains north of the modern Turkish border, are essentially unknown to archaeologists.

One of the key reasons that some surveys produce such higher site densities than others is that the former have relied on high-resolution aerial or satellite imagery to aid in site discovery. Aerial imagery has long been understood as a powerful means to discover archaeological sites in the Near East (e.g., Poidebard 1934), and in the Syrian Khabur, van Liere and Lauffray (1954–5) employed 1:20 km scale aerial photographs to map sites throughout the region. However, in most parts of the Near East, traditional aerial photographs are either not available or non-existent, and it was for this reason that archaeologists were so excited by the 1996 declassification of high-resolution CORONA

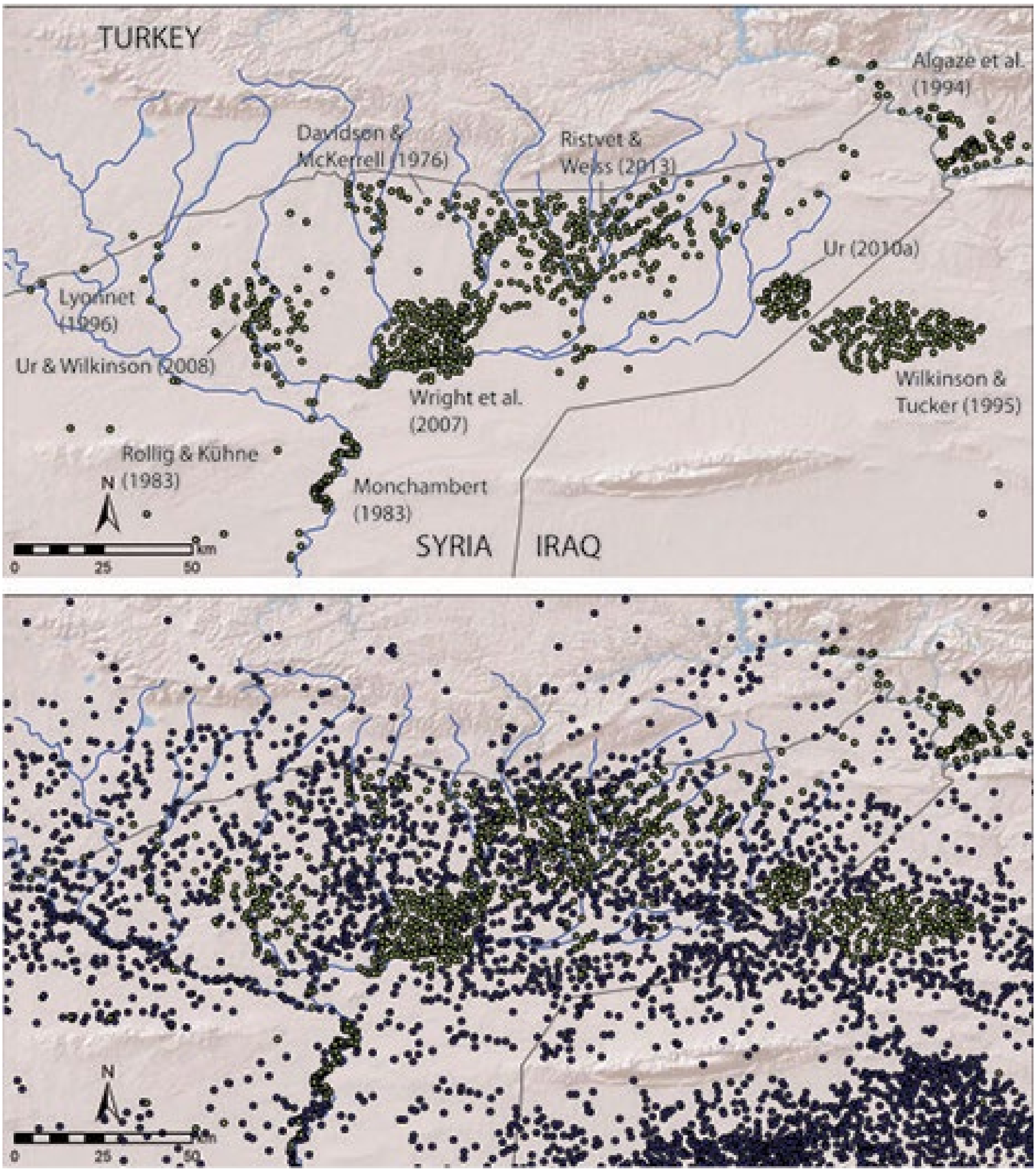

Figure 11.2. A: Map illustrating all sites in the upper Khabur Basin that have previously been recorded by archaeological surveys. B: All sites or site-like features that have been mapped by the author and his research team using CORONA satellite imagery.

satellite images (Kennedy 1998), an archive of 860,000 space acquired photographs collected as part of the United States' first spy satellite programme that was in operation from 1960–1972 (Day *et al.* 1998). Researchers who employed CORONA found that it greatly increased rates of site discovery on survey projects (e.g., Casana and Wilkinson 2005; Kouchoukos 2001; Philip *et al.* 2002; Ur 2002), facilitated the recognition of ancient field systems, canal networks, and roadways (2005; Casana 2003; 2013; Hritz 2010; Philip and Bradbury 2010; Ur 2003) and offered new perspectives on the environmental and geographic contexts of ancient settlement (Challis *et al.* 2002–2004; Casana 2008; Pournelle 2007).

While even higher resolution commercial satellite imagery is now accessible on any smartphone, the past several decades have seen widespread and dramatic transformations in land use, including urban expansion (Figure 11.3A), dam construction (Figure 11.3B), and agricultural intensification (Figure 11.3C). The transformative processes of modernisation have devastated the archaeological record, meaning that only a fraction of the sites and features extant a few decades ago are visible on recent satellite imagery. Thus, CORONA, which preserves a picture of a largely pre-industrial landscape, constitutes a unique resource for archaeology in the Near East and continues to be among the best datasets for remote identification of ancient sites and features (Beck *et al.* 2007; Casana *et al.* 2013; Ur 2013).

Despite the many strengths of CORONA, much past research has been hampered by the difficulties inherent in spatially correcting the imagery (Casana and Cothren 2008), and these challenges have resulted in a piecemeal application of the resource, with researchers only correcting imagery required for specific sites or small study areas.[2] In an effort to make CORONA more widely available and accessible, my research team developed more efficient and accurate methods to correct CORONA geometrically and has now produced high-resolution imagery for the entire Near East (Casana *et al.* 2012), made freely available through an online database (corona.cast.uark.edu). We then began a project to document systematically all archaeological sites, potential sites, and related features that are visible on CORONA across a 300,000 km^2 study area in the Northern Fertile Crescent, extending from the Mediterranean coast of Lebanon and Syria to the Zagros Mountains of northeastern Iraq (Casana 2014; Casana and Cothren 2013). We first collected all previously published archaeological surveys conducted in the region, incorporated their maps showing site locations into a GIS database, and then attempted to locate all of the sites on CORONA imagery, comparing our results to several other online archaeological site atlases. This produced a database of around 4200 sites within our study area, including those illustrated in Figure 11.2A.

To correct for the unevenness of the regional settlement record, we then investigated CORONA imagery to document unrecorded sites within and beyond boundaries of published surveys. We broke the study area into 10 x 10 km grid squares and began systematically searching through these grids, identifying all sites or site-like features. To date, we have mapped around 11,000 previously undocumented sites or possible sites, including those in Figure 11.2B. While many undocumented sites are small or ephemeral, some are large and potentially significant, such as the huge citadel and 60-ha lower town at Araban Hoyuk, Turkey (Figure 11.4A). In some parts of our study area, such as those with steep topography or dense forest cover, archaeological sites do not appear very clearly if at all, even in the case of some already well-known sites, such as the Late Roman site of Sergilla in western Syria (Figure 11.4B). In other regions, such as the upper Quoeiq River Valley in Northern Syria, the complex geology produces many features that appear deceptively like archaeological sites, making it difficult to distinguish natural from cultural features. To account for these degrees of uncertainty, we categorise site-like features as definite, probable, or possible. However, in the semi-arid plains of the upper Khabur Basin, archaeological sites appear with a very high degree of clarity, such that more than 90% of our documented sites have a certainty ranking of 'definite'.

Moreover, recent surveys have found that virtually 100% of ancient settlements documented in field survey are visible on CORONA (Ur 2010a; Ur and Wilkinson 2008; Wright *et al.* 2006–7). Thus, the region offers an excellent illustration of our methods as nearly all ancient settlements should be recognisable on satellite imagery, and there should be very few false positives.

Morphological dating of archaeological sites

While identification of probable archaeological sites on CORONA imagery is a relatively straightforward process, particularly in a region like the Khabur Basin, simply knowing the location of a site tells us nothing about its occupational history. Most archaeologists would assume that at this stage, we have no path forward other than to visit sites on the ground and collect surface artifacts as has been our practice for more than a century. However, imagery analysis also reveals a remarkable diversity in site morphology, with evident differences in a whole range of variables including site size and shape, the degree and character of mounding, the severity of erosional gullies, the presence of rectilinear features, and so forth. Tony Wilkinson recognised the potential analytic value of site morphology, particularly in the degree to which settlements of different periods tended to be more 'nucleated' or 'dispersed'. Indeed, these differences constitute a key organising principle of his 2003 book, with chapters devoted separately to 'Landscapes of Tells' (i.e., nucleated settlements of the Bronze Age) and 'The Great Dispersal' (i.e., dispersed and intensified settlements of the Iron Age and later).

In fact, nucleation and dispersion are just one axis of variability in site morphology that we could potentially analyse. Archaeological sites are the product of ancient settlements that varied widely across time and space in their organisation and aesthetics (e.g., Roberts 1996),

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[2] In fact, during the 1960s, the primary advantage of CORONA over more traditional U2 spy plane acquired imagery was its regional scale coverage (Day *et al.* 1998).

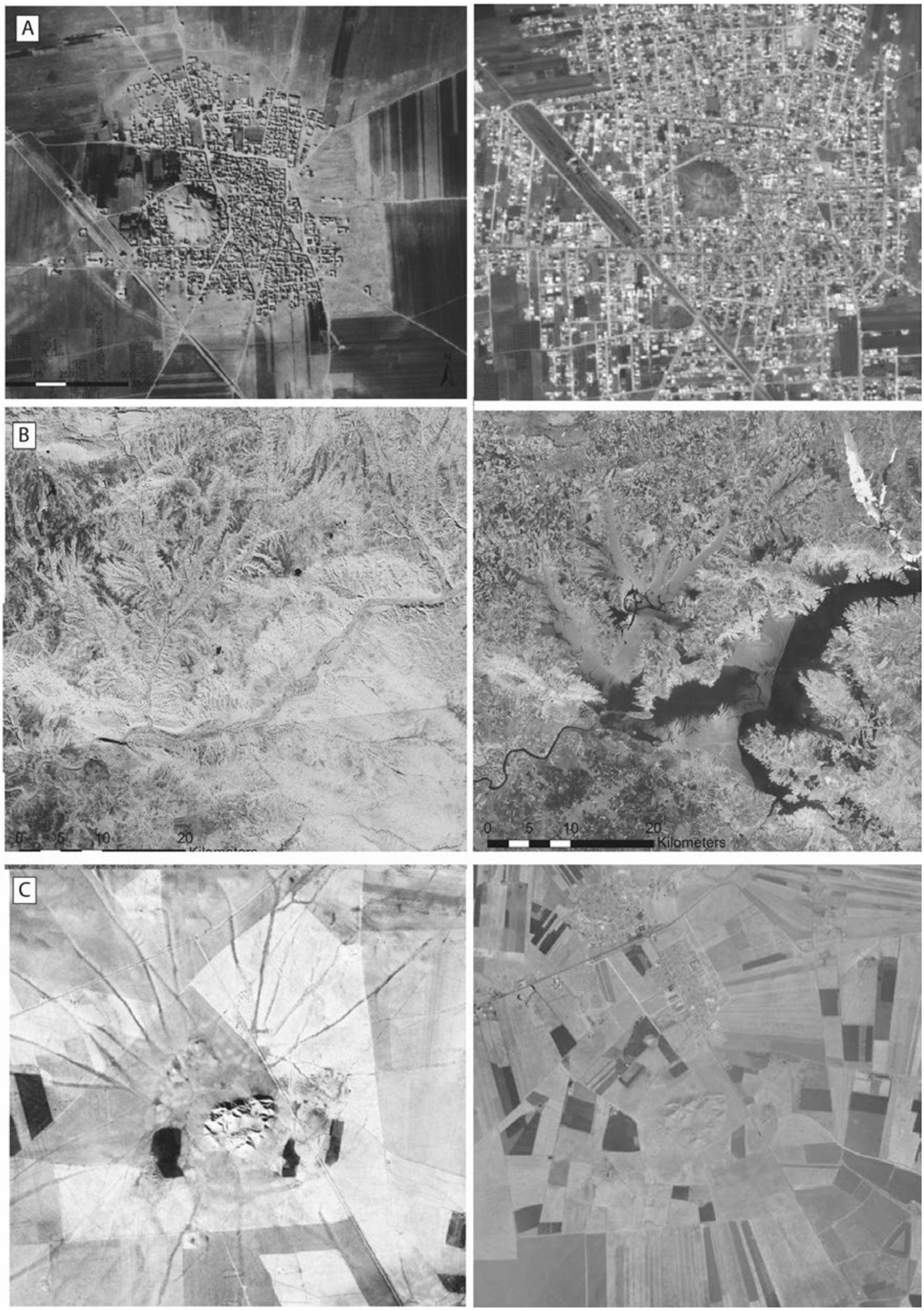

Figure 11.3. Examples of landscape transformations in the Near East, comparing visibility of archaeological sites and features in CORONA imagery from the late 1960s to modern high-resolution imagery: A) The nearly perfectly circular fortified lower town at Tell Rifa'at, Northern Syria, has been completely obscured by urban expansion of the modern town. B) Construction of major dams such as the Ataturk Dam, Turkey, pictured here, has inundated thousands of archaeological sites. C) Intensification and mechanisation of agriculture has obscured many sites and features, such as the radial systems of ancient roads or "hollow ways" that surround Tell Brak, eastern Syria.

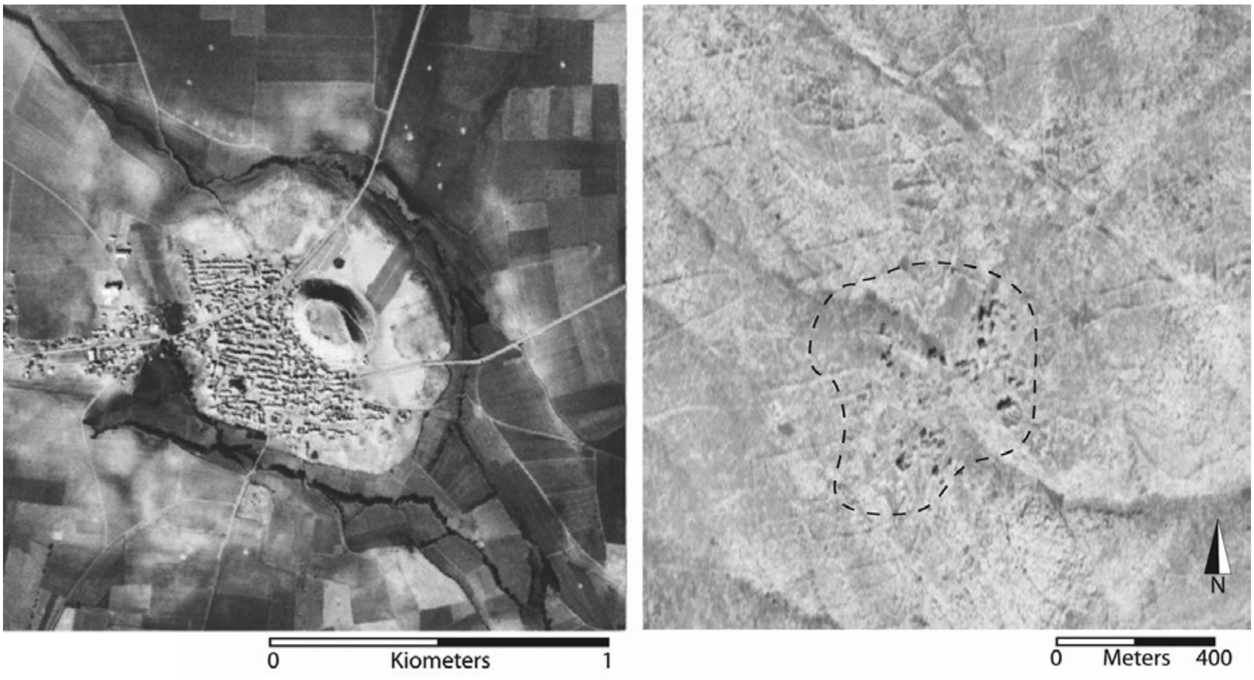

Figure 11.4. Sites appear with varying degrees of clarity on CORONA imagery. Examples here include: A) the 60+ ha site of Araban Hoyuk, which despite its size, is still unpublished, and B) the Late Roman site of Sergilla in western Syria, which despite being very well known and easily visible on the ground due to extensive standing architectural remains, is difficult to recognise in imagery. On the other hand, faint traces of centuriated fields can be recognised around the central occupational area of the site.

and this fact, combined with the taphonomic processes that affect their decay, produce sites that today are likewise distinct in their morphology (Casana 2012). Thus, if documented systematically, and analysed critically, site morphology can be used to infer the date of individual sites as well as to map regional settlement patterns.

The morphology of sites, as evident on aerial photographs, was first used to classify mounds in the Syrian Jazira by van Liere and Lauffray (1954–5), although they lacked much of the ground control necessary to date them. Wilkinson (2003; Wilkinson *et al.* 2003; 2005; 2014) takes this notion further, treating temporal differences in site morphology as the result of major transformations in the organisation of settlement, land use, and political economies. The approach taken here builds on Wilkinson's work, by establishing a more formalised site taxonomy with which we can classify the more than 15,000 sites in our database in order to reveal even more nuanced morphological distinctions, and presumably therefore, temporally or culturally diagnostic features.

It is important to note that dating a site based on its morphology requires a robust comparative sample of similar sites that have already been recorded by regional archaeological surveys, ideally in nearby areas. With such a sample, some particular types of site, or features on a site, may be relatively easy to date with some confidence, while for a large percentage of other sites their morphology is insufficiently distinctive to permit dating on form alone. This problem can be seen as essentially parallel to the issues involved in dating surface artifacts collected in the course of a regional survey. Our ability to date surface artifacts depends firstly on an excavation having been conducted in the region previously, but even with this information, many artifacts collected from the surface of a site may be difficult to date with certainty. Some artifacts can be dated very precisely, such as Roman *terra sigillata* wares that can be placed within a few decades, while other types, such as the well known red-black-burnished ware of the Levant, can be easily dated with a high degree of confidence, but only to within a 500-year window in the 3rd millennium BC. A large percentage of other artifacts from most surface collections cannot be dated with any confidence, or can only be speculatively dated, based on their fabric or surface treatment, to broad periods such as 'Bronze Age'.

Despite these difficulties, archaeologists now generally understand that by assembling a large enough collection of surface artifacts from an individual site, we can build up a picture of its settlement history, even if some artifact type fossils are more diagnostic, better preserved, or easier to find on the surface than others. Certainly, excavating an archaeological site is a much better way to determine its occupational history, but doing so on every site within a survey's study area would be impractical given cost and time constraints, not to mention illegal under most contemporary archaeological permitting processes. Thus, dating sites based on analysis of surface artifacts represents a trade-off, in which we sacrifice certainty and accuracy at any individual site, for the ability to date hundreds of sites within a survey region.

Dating sites morphologically follows essentially the same principles as surface survey, but is one more step removed; it enables us to evaluate thousands or tens of thousands of sites across much larger regions than a conventional survey, but sacrifices accuracy and certainty at any individual site. Thus, while we will know less about each site than if we had visited them in the field, we will be able to gain insights into regional settlement patterns that are not recognisable at the scale of an individual survey project.

Distribution of common morphological types

Our efforts to refine a morphological taxonomy of sites and analyse the temporal and geographic distribution of these variables is an ongoing project, but below I illustrate several examples of how this approach can work. As discussed above, Tony Wilkinson was the first to recognise the major transition from the nucleated patterns of tell-based settlement that predominated across much of the Near East during the Bronze Age, to the more intensive but dispersed patterns of settlement that characterised the mid 1st millennium and later. Because they often form prominent mounds, nucleated Bronze Age settlements are particularly easy to recognise on CORONA satellite imagery, which was generally collected in the late afternoon in order to highlight topography.[3] Survey data from the Northern Mesopotamian plains show consistently that prominent mounds have their primary phases of occupation prior to the mid-1st millennium BC, and critically, that little or no evidence of Bronze Age settlement is found away from mounds. Thus by mapping all mounded sites, which can be done with a high degree of confidence (Figure 11.5A), we can illustrate the maximum possible distribution of settlement during any phase of the Bronze Age. Of course, many of these mounded sites were not actually occupied contemporaneously, and some probably do not have Bronze Age occupation,[4] but even the coarse morphologically derived date of 'Bronze or early Iron Age' offers many analytic opportunities (e.g., Kalayci 2013; 2016).

Within the broad category of 'mound' there is wide variability in shape, size, and associated features that we can use to estimate the date of sites more precisely. For example, well-known *kranzhugel*-type sites, found at the fringe of in the Syrian steppe, uniformly date to the mid- to late-3rd millennium BC.

Thus when we discover a *kranzhugel*-type site on satellite imagery, we can quite confidently assume it was occupied during the second-half of the Early Bronze Age (Jakoby 2013), although we cannot determine whether the site possesses either earlier or later phases of occupation, as are known to be the case at sites such as Tell Chuera or Tell Beydar. Similarly, when a mounded site in the Jazira has radial route systems (Figure 11.3C), or 'hollow ways' as they were terms by Wilkinson (1993), and individual roadways are both very wide (>50 m) and terminate in open pastureland, we can confidently argue that the site and the route systems date to the Early Bronze Age (Wilkinson *et al.* 2010). We cannot on the other hand assume that sites outside of the Jazira that possess formally similar radial routes are also Early Bronze Age in date, as numerous examples from later periods have now been identified (Casana 2013b).

While both hollow ways and *kranzhugel*-type sites have been much discussed, other morphological features that make some mounds distinct from others have gone largely unnoticed. For example, a subset of mounded sites possesses deep erosional gullies (Figure 11.6). Our analysis has to date mapped 118 sites with severe gully systems, and their distribution does not reveal any obvious environmental reason that these sites should be distinct from other mounds (Figure 11.5B). Of these sites, 41 have been recorded by surveys or excavated, and nearly all: 1) have a very long history of Early Bronze Age occupation, 2) lack significant occupation postdating the 3rd millennium BC, and 3) tend to be quite tall, with excavated examples showing evidence of fortification or monumental architecture. Thus, the unrecorded sites that exhibit this distinctive erosional pattern can be argued to have had a similar occupational history.

Non-mounded or topographically flat sites also often possess morphological characteristics that enable us to estimate their date. Wilkinson and others (Ur 2003) have long noted that sites of later periods, particularly of the Roman/Parthian, Late Roman/Sasanian, and medieval phases often appear on satellite imagery as non-

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[3] In contrast, modern high-resolution satellite imagery is typically collected at mid-day in order to maximise reflected light off the earth's surface.

[4] Determining that a multi-period mound was *not* occupied during a particular phase is fundamentally based on an absence of evidence; it means only that artifacts of that phase were not found during surface survey. There can be many reasons that surface collections do not show occupation of a particular phase (e.g., collections were small or hasty, occupational strata are deeply buried, type fossils for that period are more difficult to identify, etc.). Thus when reading survey reports, we should remember that positive versus negative statements of occupational periods at a site carry far different weight.

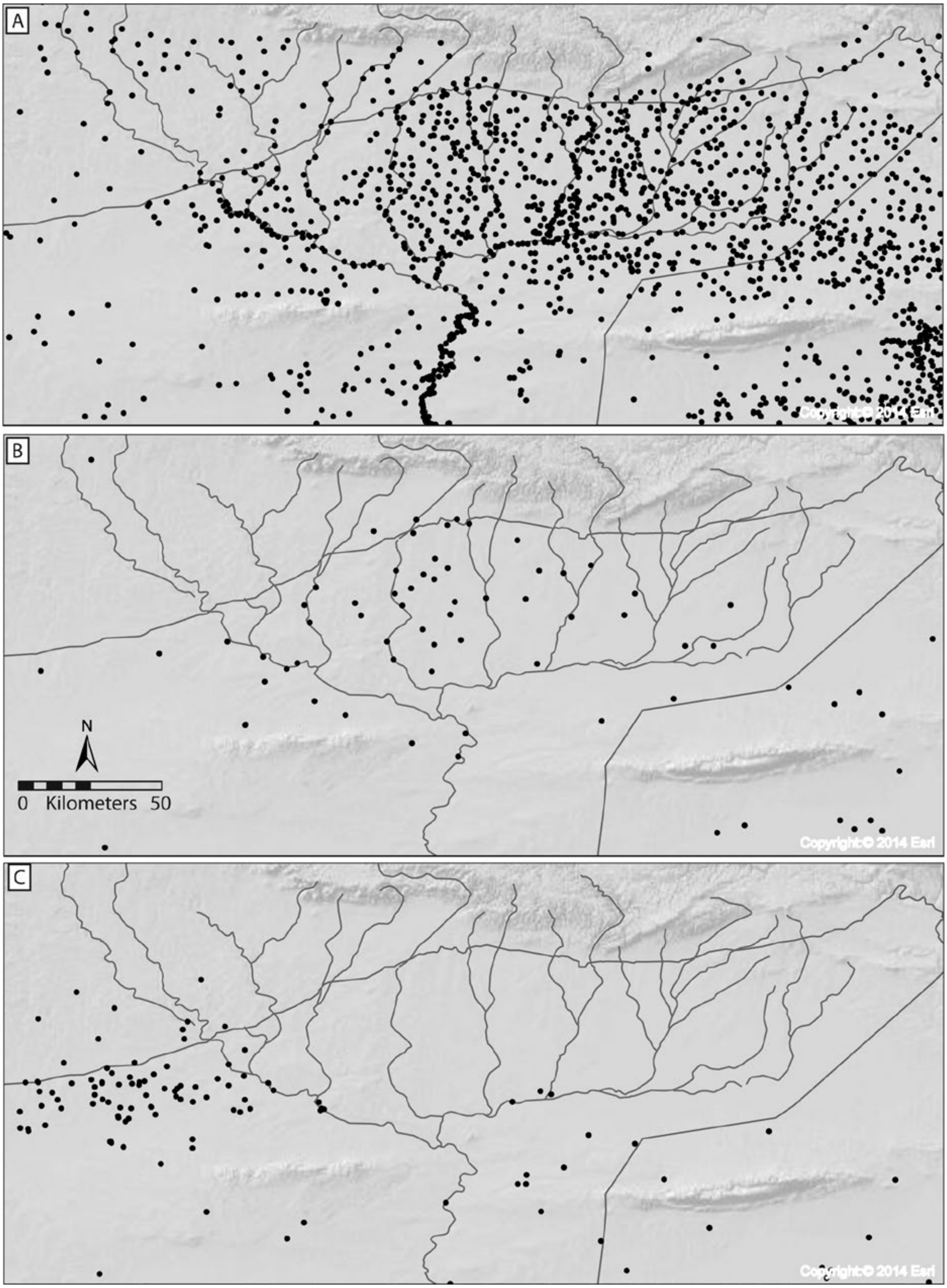

Figure 11.5. Distribution maps for sites of three different morphologies. These include: A) all mounded sites, B) mounded sites with severe erosional gullies, C) topographically flat sites with rectilinear architecture and a distinct square structure.

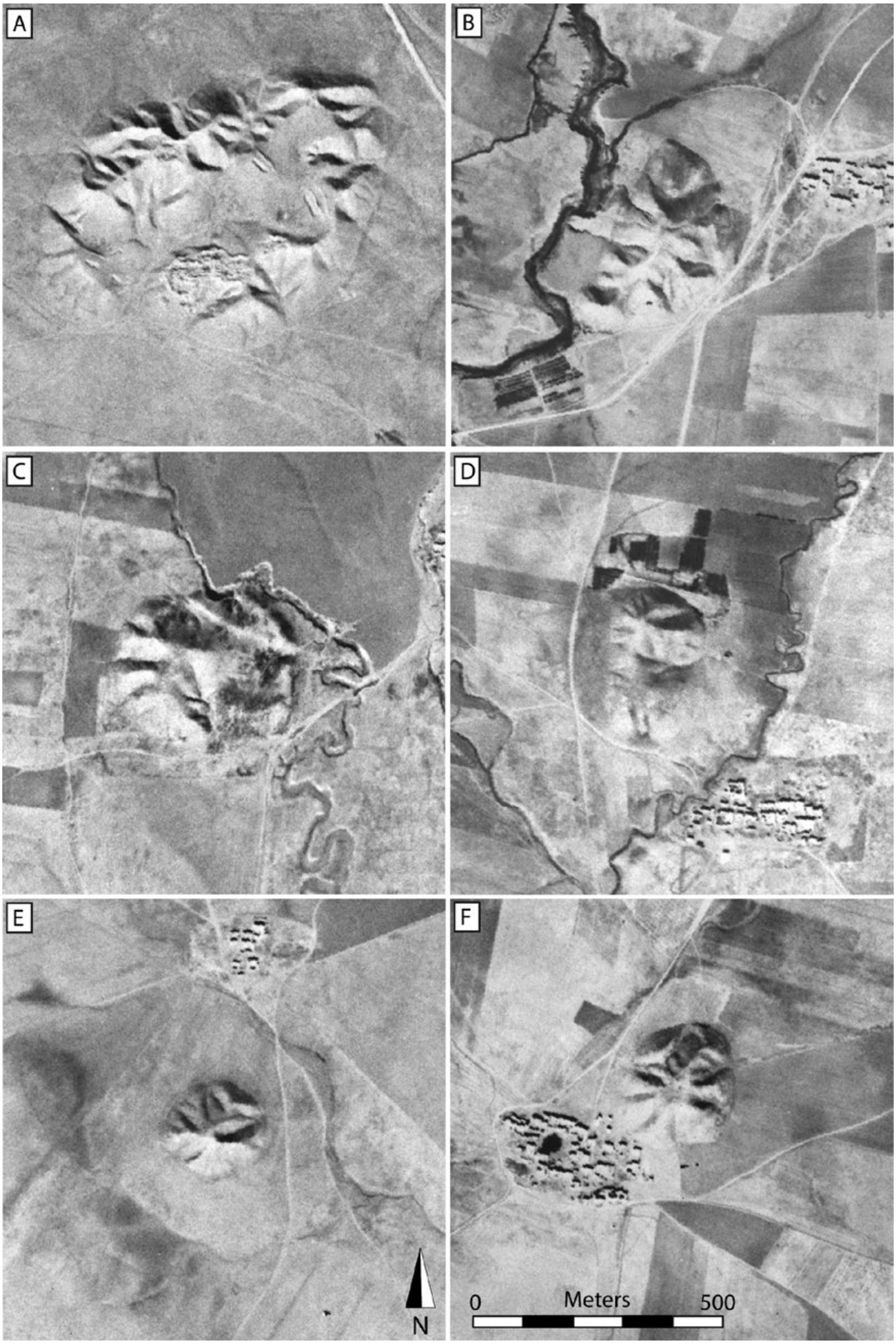

Figure 11.6. Mounded sites with severe erosional gullies. Sites with these characteristic features, the distribution of which is shown in Fig. 11.5B, tend to have long occupational histories through the 3rd millennium BC, are often home to monumental architecture or fortifications, and have little significant settlement in later periods.

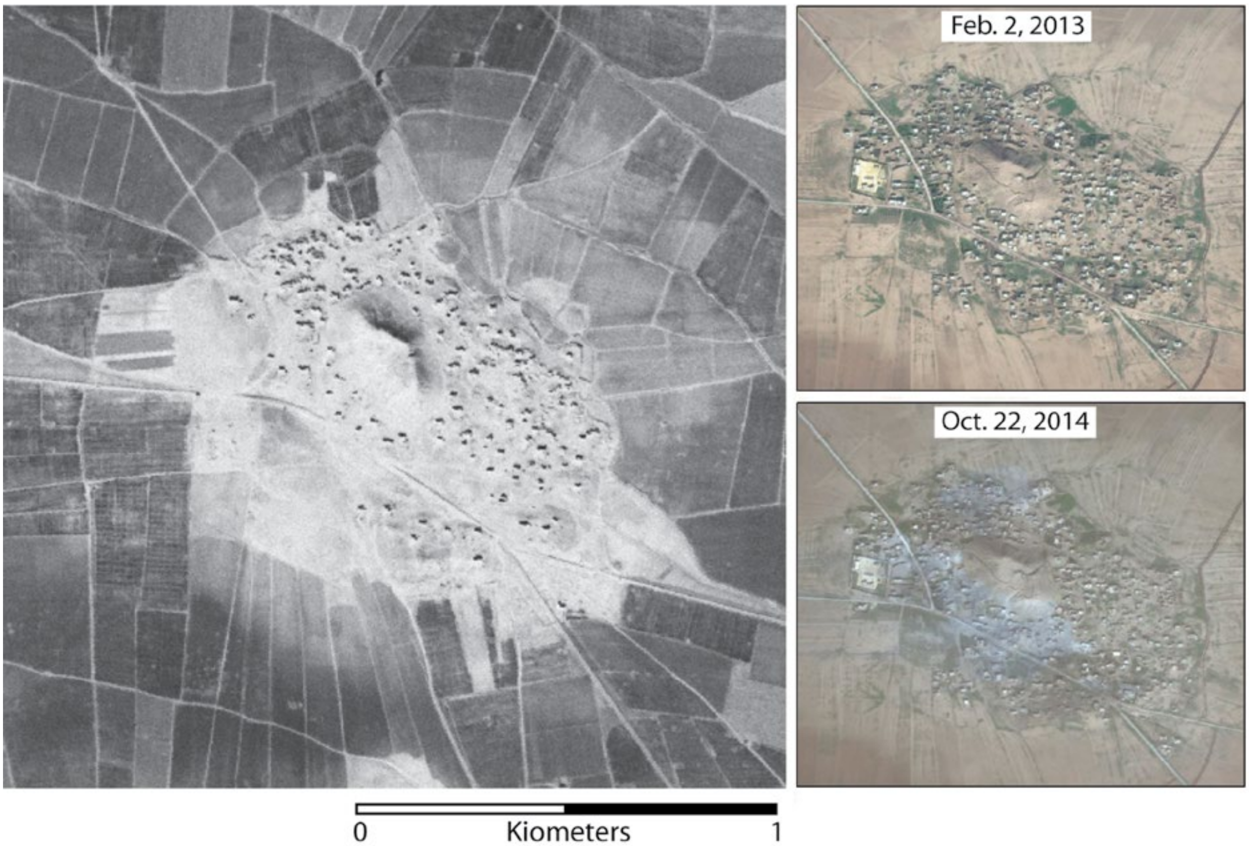

Figure 11.7. Tell Hajeb, northern Syria. While briefly recorded during a survey in the early 1990s, the true expanse of the site, covering almost 80 ha, went unnoticed in part due to the presence of a modern village that covers much of the lower town. Unfortunately, the village suffered severe damage during fighting in October 2014, as revealed in high resolution imagery in which large areas of the village are reduced to rubble (imagery courtesy Digital Globe © 2015 and ASOR Syrian Heritage Initiative

uniform lumpy patches, occasionally with fragments of rectilinear architecture visible. Within the large group of sites possessing those broad characteristics, a subset of 240 such possesses a distinct square structure, typically measuring 100–150 m on a side (Figure 11.7). Only 18 of these sites have been recorded by surveys (a number that likely results from the lower visibility of topographically flat sites as compared to mounded sites), but all of them show a consistent date in the Late Roman or Early Islamic Period. These square buildings were often originally constructed as forts or caravanserais, and the distribution of sites with these features reflects this likely purpose (Figure 11.5C). These sites are heavily concentrated in desert regions, with a dense cluster in Northern Syria, on what is the modern Turkish-Syrian border and was historically the Roman/Parthian border.

Identification of atypical sites and historical geography

The methods described thus far are a powerful means of revealing previously unrecognised patterns in the morphology of archaeological sites and the distribution of key features, but this approach can also help identify sites that are unusually large, or which possess unusual features that make them potentially significant. Identification of unique sites can be a great aid to reconstructing the historical geography of the region. Earlier generations of scholars who attempted to identify ancient cities in the modern landscape typically relied exclusively on modern toponyms and made linguistic arguments to link them to historically known cities (e.g., Astour 1963). The approach I present below instead begins with two assumptions: 1) large ancient cities are preserved as archaeological sites that are unlikely to be overlooked in a systematic remote sensing-based survey and 2) these archaeological sites generally possess morphological characteristics that enable them to be at least roughly dated. Below I illustrate three examples of large and unusual sites whose respective features and locations make them good candidates for several, as yet unidentified, historically known cities.

Tell Hajeb

Analysis of CORONA imagery in far Northern Syria between the Euphrates and the Balikh reveals a large number of previously unrecorded sites, although the

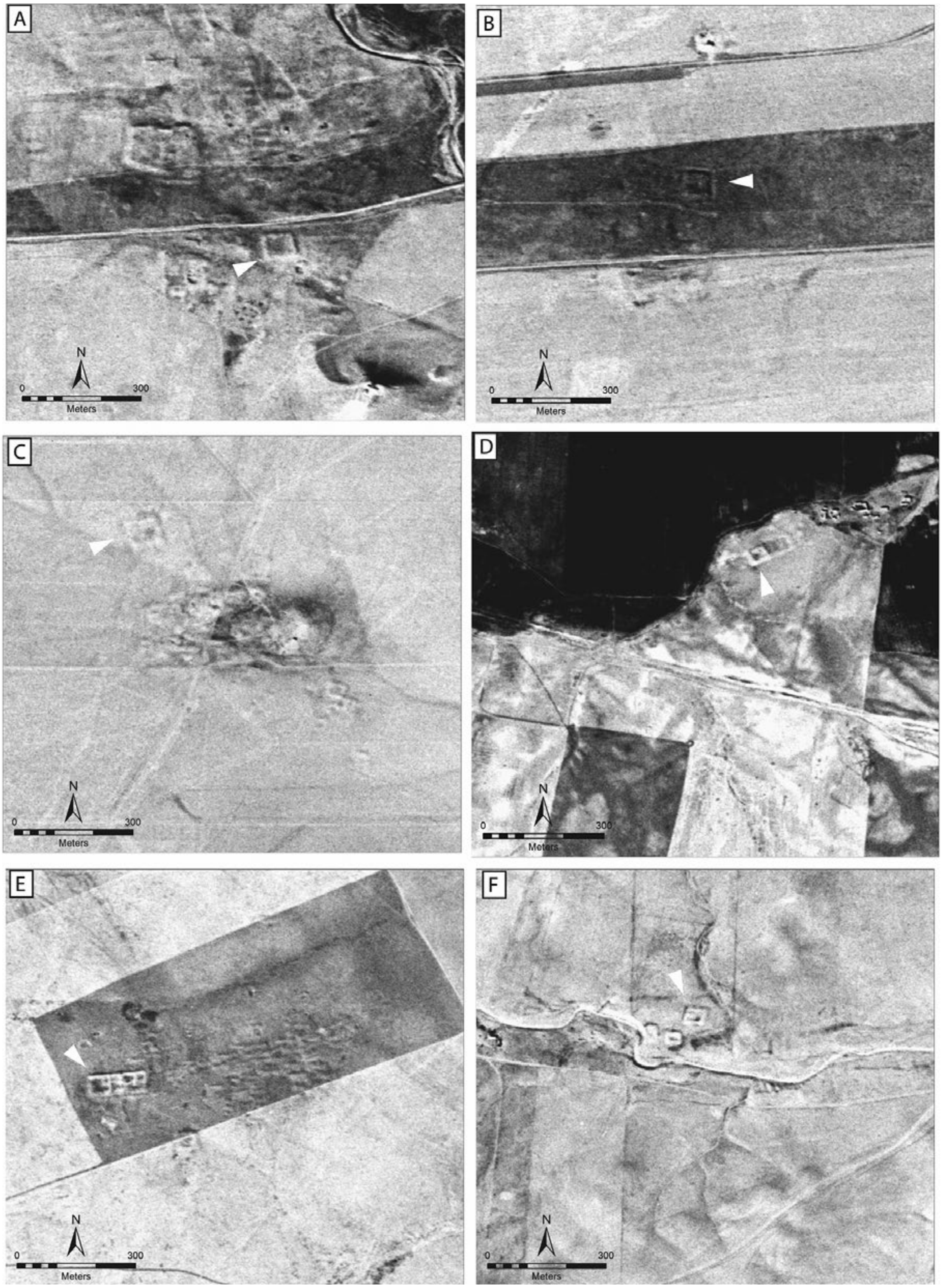

Figure 11.8. Topographically flat sites with a distinctive square structure, the distribution of which is shown in Fig. 11.5C. These sites tend to be Roman/Late Roman/Early Islamic in date. The square structures, when recorded, seem to have been originally constructed as forts or caravanserais.

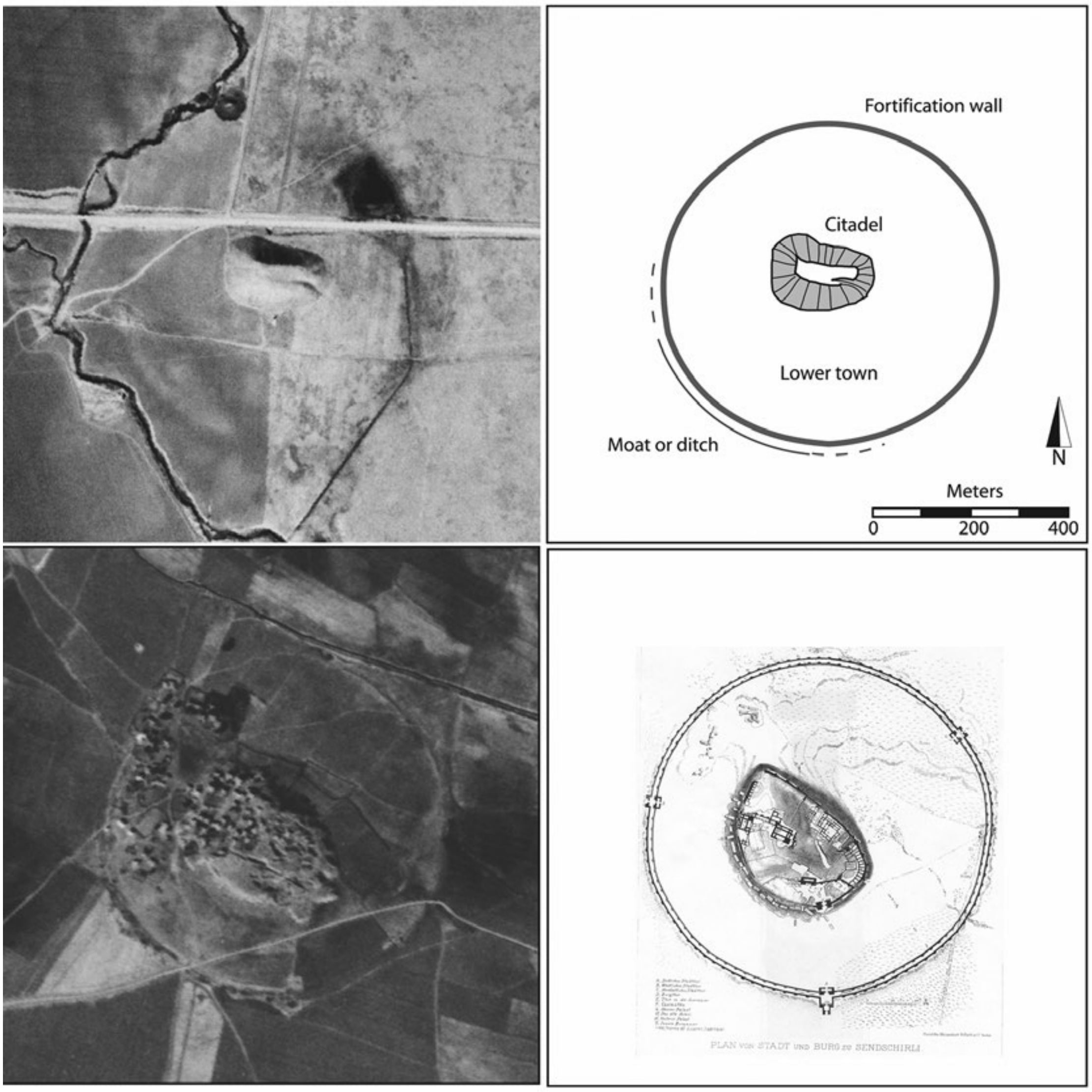

Figure 11.9. Akziyaret Tepe, Southern Turkey (top) compared to Zincirli Hoyuk (bottom). A subtle, perfectly circular fortified lower town is visible surrounding the still unpublished site of Akziyaret Tepe. The urban plan, with a circular lower town built around a pre-existing tell is a striking parallel to the early Iron Age settlement at Zincrili; both occupations measure about 40 ha.

most prominent mounds in the area were documented in a joint German-Syrian survey project in 1991–2 (Einwag 1993). During this reconnaissance effort, the team recorded the mound of Tell Hajeb (Figure 11.7), which they describe as the tallest mound in the region (ibid.: 34). They also note the existence of a lower town, but which is largely covered by a modern village. The same site was briefly mentioned by Thureau-Dangin *et al.* (1931) as the find-spot of two Neo-Assyrian orthostats in 1899. Aside from these notes, Tell Hajeb is not well known and its potential significance remains unrecognised. Analysis of CORONA imagery however reveals that the 1960s village is actually built on top of a mounded lower town covering at least 80 ha in area. The prominent mound at the centre of the site is shown to in fact be the citadel of a larger ancient city, and the dating of the site by the survey, as primarily prehistoric, Bronze, and Iron Age, suggests it is one of the largest pre-classical sites in Northern Syria.

A Bronze Age city of this size is almost certain to have been mentioned in historic records from the region, and based on its location Tell Hajeb is a good candidate for the as yet undiscovered city of Irridu. Irridu played a prominent role in the political history of the region, particularly during the 2nd millennium BC (Bryce 2009: 337). The city is mentioned several times in letters from King Zimri-Lim of Mari, and is probably best known for the role it played in the founding of Yarim-Lim's dynasty at Alalakh (Tell Atchana) in the Amuq Plain to the west. The location of the city is best recorded later however, in Hittite accounts of the 1340 BC invasion of the Kingdom of Mitanni, led by the Hittite prince Piyaššili and the would be king of Mitanni, Šattiwaza, during which they proceeded from Carchemish on the Euphrates River, stopping in Irridu, and onwards through Harran in the headwaters of the Balikh (Opitz 1927).

The region between the already well known sites of Carchemish and Harran (Figure 11.1) has few possible candidates for Irridu, as a city of this significance would likely have been a prominent mound with an expansive fortified lower town, like most other contemporary cities. Tell Hajeb is essentially the only major mounded site to fit this description within the region,[5] and in this case, surface survey even confirms occupation during the 2nd millennium BC (Einwag 1993).

Because Irridu later served as a refuge for the remnants of the Mitanni royal court in the late 13th century, the city was ultimately destroyed and the farmland around it sown with salt during Adad-Nirari I's campaign of 1290 BC (Weidner 1929). The location of Tell Hajeb accords with this historical record, because the city is just 2 km to the west of the site of Arslan Tash which was founded, following the destruction of Irridu, as a new Aramaean city (Bryce 2012), and later became a key Neo-Assyrian administrative centre. Of course, confirming any historical identification is difficult without epigraphic evidence recovered in excavations, and any such effort at Tell Hajeb in the near future is highly unlikely. The modern town at the site was subjected to severe damage during the intense fighting in neighbouring Kobane during October 2014 (Figure 11.7 B–C) and remains in a volatile area of Syria. Nonetheless, the remote sensing-based approach advocated here enables us to explore the landscape in new ways and to build testable theories.

Akziyaret Tepe

Another potentially significant, but as yet unpublished, site is one dubbed Akziyaret Tepe[6] (Figure 11.8A–B) located in the northern Mardin Plain of Turkey. At first glance, the site appears to be a typical, small, steep and flat-topped tell measuring around 3 ha, but closer analysis reveals that the mound is surrounded by an almost perfectly circular fortification system, enclosing an area of 40 ha. Circular fortification plans like this one are rather unusual in the Near East, but are known from Aramaean cities of the Early Iron Age to the west, famously at Zincirli Hoyuk (Figure 11.8C–D) in Southern Turkey, where a wall encloses an area of almost exactly the same size (Casana and Herrmann 2010; Herrmann 2017; Schloen and Fink 2009). Contemporary Tell Rifa'at (Iron Age Arpad) also possesses a nearly perfectly circular fortification wall (Figure 11.3A), although enclosing more than 120 ha (Casana 2012; 2013a).

The strikingly close parallel between Akziyaret Tepe and Zincirli suggests that the former was also fortified during the Early Iron Age, as the circularly planned fortifications found at both sites are unknown is any other period in Northern Mesopotamia. Akziyaret Tepe is thus a good candidate for the city of Pauza/Pa'zi that is thought to be located along the southern edge of the Tur Abdin Range. Pauza is first mentioned in the annals of Ashur-bēl-kala (1073–1056 BC) but is best known from Adad-Nirari II's campaign of 900 BC (Grayson 1991), during which he claims to have vanquished the Temanites, a group of Aramaeans, 'from Pauza to Nisibis' (Lipinksi 2000: 111–112), the latter city located at modern Nusaybin on the Turkish-Syrian border (Figure 11.1). If Akziyaret Tepe is indeed Pauza, this would help explain its ephemeral appearance today, as the city would have only been occupied for about 200 years before it was destroyed by Adad-Nirari II. Further evidence for this possible identification could come from a surface survey confirming the date of occupation on the lower town, while a geophysical survey could potentially reveal an urban plan similar to that now well documented at Zincirli.

Koçlu Tepe

Another unusual site in the Khabur region is the enormous site of Koçlu Tepe, located just 7 km south of Akziyaret Tepe. The site is surrounded by the remains of a fortification system that encloses an area of approximately 140 ha, making it probably the largest pre-medieval site in the Khabur Basin (Figure 11.9A–B). The small modern village of Koçlu Koyu covers around 5 ha at the centre of the site (Figure 11.9D), but the ancient settlement is otherwise not heavily impacted by modern land use. On the western edge of the site, adjacent to a perennial stream, there is a small upper mound, most likely the remains of an upper citadel, measuring about 5 ha in area (Figure 11.9C). The height of the upper mound is difficult to determine precisely, but the strong shadowing on its northern side suggests it is likely 5–10 m elevation. The extensive lower town, by contrast, exhibits little topographic expression. Drainage channels and gullies have not formed along the mound, while modern and 1960s-era field boundaries and roads do not respect the edges or shape of the lower town, suggesting mounding of probably not more than 1–2 m above plain level.

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[5] Kazane Hoyuk at the northeast corner of the Harran Plain is the only other large Bronze Age city in the region, but this site was largely abandoned at the end of the Early Bronze Age (Creekmore 2010).

[6] Akziyaret Tepe and Koçlu Tepe discussed in the next section have not, to the author's knowledge, been previously published (although may have been noted in Turkish grey literature). The names for the sites used here are simply based on the names of modern villages located at each site. Most known sites in the region use the Kurdish/Persian 'tepe,' rather than 'höyük' or 'tell,' and so I follow that convention here.

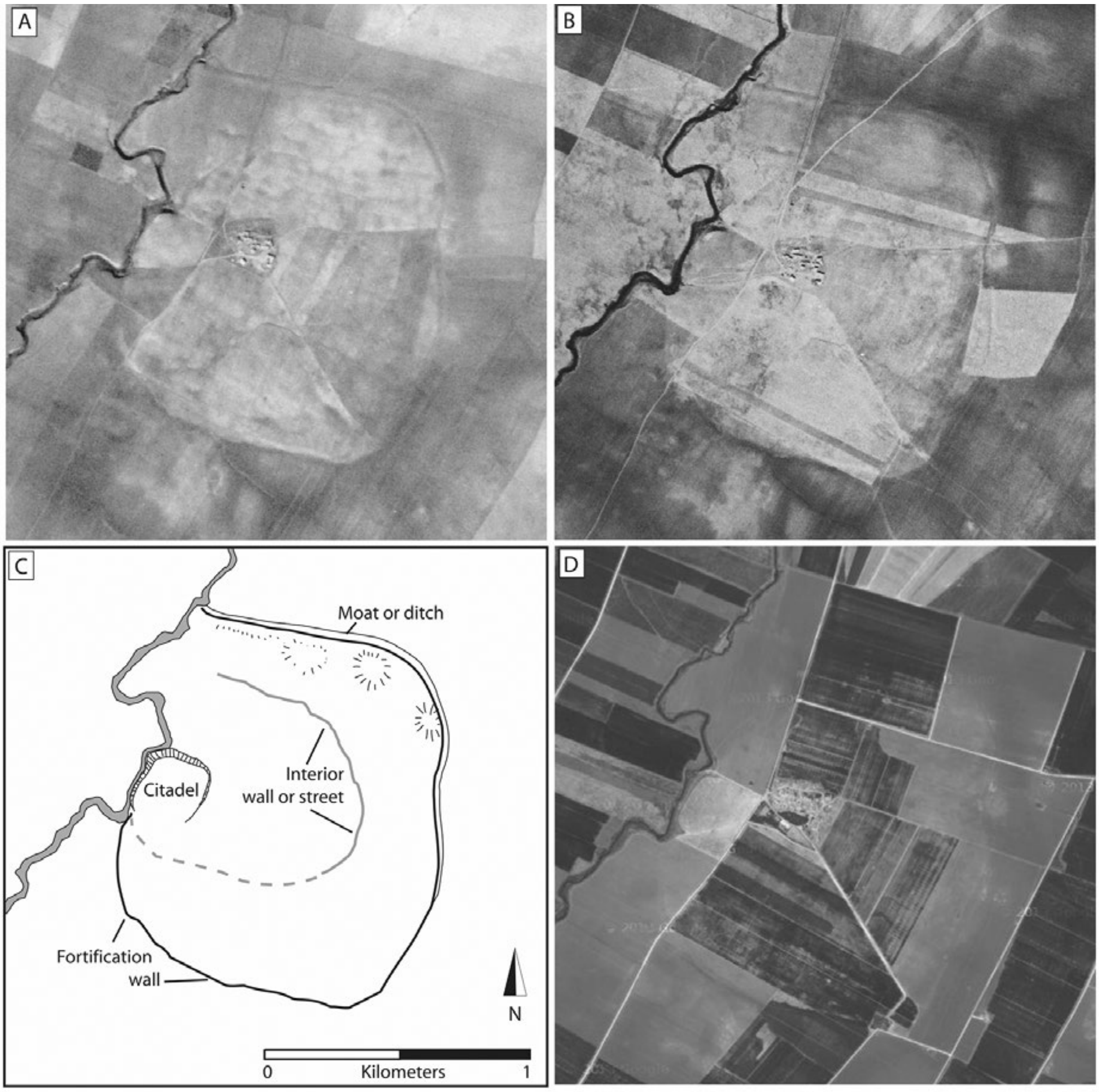

Figure 11.10. Koçlu Tepe, Southern Turkey. As it appears on CORONA imagery from (A) 1967 and (B) 1969. The images can be used to create an interpretive plan of the site (C), showing a fortified lower town with a total area measuring more than 140 ha. Modern imagery (D) reveals that much of the site, while more difficult to recognise, has not been impacted by recent development.

The fortification system itself is characteristic of many Bronze and Iron Age sites in the region, appearing as a dark linear feature of 15–20 m width, probably the remains of a ditch or moat that surrounded an adjacent interior wall. The interior of the lower town is much lighter in colour than the surrounding flood plain, typical of anthropogenic soils found on sites throughout the Khabur region (Menze and Ur 2012). The lower town possesses numerous low, undulating mounds measuring 2–4 ha in size, suggestive of the complex topography of a once large city. Between 300–400 m inside the outer fortification system, there is a faint, darkened linear feature, most evident on the 1102 CORONA image (Figure 11.7A). This feature could be the remains of a secondary interior fortification, or perhaps a street that paralleled the wall as is known from Carchemish (Wilkinson *et al.* 2011). Taken together, the features at Koçlu Tepe reveal that the site was once a major city, among the largest, and therefore likely the most important, in the region, but its shallow depth suggests a relatively short period of occupation, as more than a few centuries of activity would probably have led to greater accumulated depth of cultural deposits.

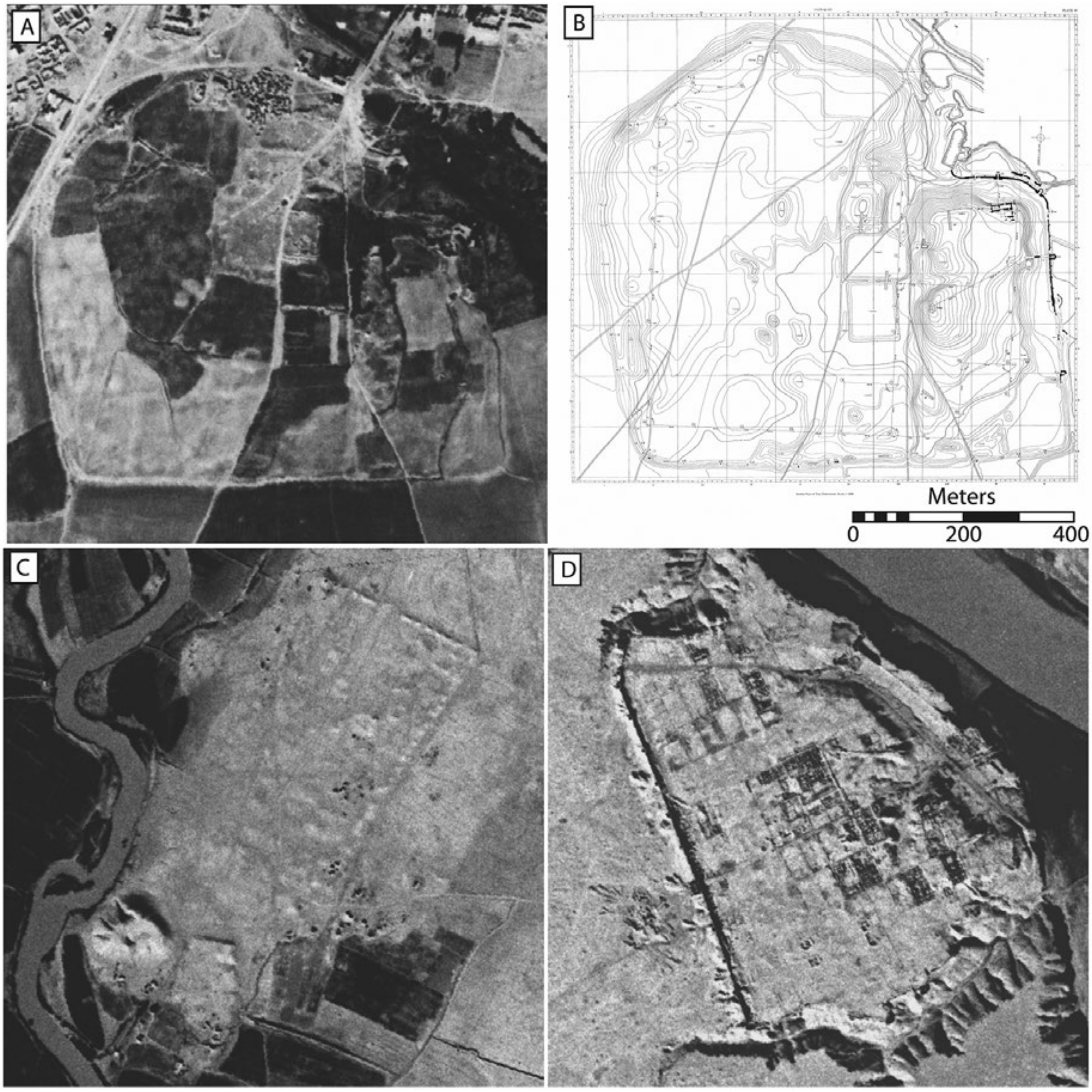

Figure 11.11. Tell Fakhariyah (A) on a CORONA image and (B) as it was mapped by an Oriental Institute team (after McEwan *et al.* 1958). The 70 ha rectilinear lower town is entirely Roman and later in date, while the Bronze Age occupation at the site is known only from the 8 ha mound in the southeast. Most large late period sites appear with orthogonal urban planning and well-preserved fortifications, as at (C) Tell Sheikh Hammad and (D) Dura Europos.

The fact that the ancient settlement at Koçlu Tepe was organised with an upper citadel surrounded by a fortified, densely occupied lower town implies that the site is of Bronze or Iron Age date. In Selecuid and later times, new foundations of the size of Koçlu Tepe were almost always orthogonal in plan and rarely followed the ancient Near Eastern model of an upper town/ lower town, which was common in Upper Mesopotamia from at least the late 4th millennium BC. Furthermore, urban sites of the mid-1st millennium BC and later are generally much better preserved than Koçlu Tepe, with extant fortification walls and remains of rectilinear architecture within the city, as is the case, for example, at the 50 ha Seleucid and Roman site of Dura Europos on the Syrian Euphrates River (Figure 11.10D) or at the Neo-Assyrian and Neo-Babylonian lower town at Tell Sheikh Hamad (Figure 11.10C). A pre-Bronze Age date is also unlikely as most Late Chalcolithic and earlier sites in the region are either much smaller than Koçlu Tepe, or have much more dispersed patterns of occupation as has been documented at Hamoukar and Tell Brak (Ur 2010a; Ur *et al.* 2007; 2011).

Koçlu Tepe's closest parallels in terms of size and preservation are the largest Early Bronze Age sites found throughout the Jazira region, from the east at Tell

Figure 11.12. Major Early Bronze Age sites from the Northern Fertile Crescent as they appear on CORONA imagery, including (A) Tell Mozan, (B) Tell Leilan, and (C) Kazane Hoyuk. For comparison, Carchemish (D) is mostly 2nd and 1st millennium BC.

el-Hawa, Tell Leilan (Figure 11.11B), Tell Brak (Figure 11.3C) and Hamoukar, to the west at Tell es-Sweyhat, Kazane Hoyuk (Figure 11.11C), Tell Hadidi, and Tell Mardikh (Ebla). Tell Mozan measuring

120 ha (Figure 11.11A) is a reasonably close parallel to Koçlu Tepe, with an upper and lower town and a fortification system that appears similar in terms of planning and preservation. However, Koçlu Tepe is located only 1.5 km from the aptly named Böyük Tepe ('Big Mound'), a prominent mounded tell site of approximately 15 ha in area (Figure 11.6B). As discussed above, the distinctive deep erosional gullies at Buyuk Tepe leave little doubt that the site is a major Early Bronze Age settlement, suggesting that Koçlu Tepe is likely later in date.

If we accept the argument that Koçlu Tepe postdates the 3rd millennium BC, but predates the Seleucid Period, we might suspect it is a Neo-Assyrian city. However, Koçlu Tepe is twice the size of Tell Ahmar (ancient Til Barsip), known to have been the primary administrative centre for the entire Jazira region but measuring only 70 ha (Morandi Bonacossi 2000). Other secondary Neo-Assyrian towns are even smaller, as at Tell Sheikh Hamad (40 ha) or Arslan Tash (20 ha). Moreover, the Neo-Assyrian administrative divisions (*nāglu*) within the Jazira are well known historically

(Kühne 1995; Morandi Bonacossi 1996; Fales 1990), with Koçlu Tepe, probably in the district of Guzanu, overseen from nearby Tell Fakhariyah. It strains credulity to think that a city twice the size of the primary Neo-Assyrian regional capital would not find mention in the rich historical record from this period.

Thus, by process of elimination, the most likely date for the massive city at Koçlu Tepe is in the Middle or Late Bronze Ages (circa 2000–1200 BC), and if that is true, the site is a good candidate for the elusive Mitanni capital of Waššukanni. Since the early 20th century, scholars have believed that Waššukanni must be located somewhere in the upper Khabur Basin (e.g., Weidner 1917: 58; 1923; Forrer 1920: 19–21), but there remains no consensus about precisely where. Opitz (1927) argued that Waššukanni was likely in the vicinity of Ras al-Ain on the Syrian-Turkish border, and based on that suggestion, von Oppenheim (1931: 44, 56ff) became convinced that the city was located at nearby Tell Fakhariyah. While recent excavations have found some evidence of Mitanni and Middle Assyrian administrative activities at Tell Fakhariyah (Bartl and Bonatz 2013), no evidence of pre-Roman settlement has been found anywhere on the 70 ha fortified lower town (Bartl 2011; McEwan *et al.* 1958; Moortgat 1956), suggesting that during the Bronze Age, the site was a small 8 ha mound and thus a poor candidate for an imperial capital. Linguistic evidence casts further doubt on the association of Tell Fakhariyah with Waššukanni,[7] while a NAA study also suggested the ancient city is likely located outside of the central Khabur Basin (Dobel 1978; Dobel *et al.* 1977). While several other sites have been suggested as potential locations for Waššukanni, such as Tell Farfara (Ristvet 2005: fig. 5.4; Ristvet and Weiss 2013), the newly identified site of Koçlu Tepe certainly should be considered as an alternative candidate.

Conclusions

This paper has sought to briefly demonstrate some of the rich potential that analysis of regional-scale remote sensing datasets can offer archaeological investigations in the Near East and beyond. While yielding coarser data than traditional field-based investigations, the satellite remote sensing-based approach taken here has key advantages over survey and excavation. It enables us to conduct investigations at a scale that is orders of magnitude larger than that which is possible through conventional field-based approaches. As such, archaeologists can make real discoveries and offer unique insights that would be impossible through conventional survey or excavation. The approach also offers complete independence from the politics and bureaucracies that shackle modern archaeology. Remote sensing technologies enable investigators to explore the archaeological landscape freely, systematically, and comprehensively, across national borders, through minefields, and without a permit, or even a plane ticket. It allows us to document temporal and regional patterns in the morphology and distribution of sites, to identify subtle associated features including lower towns, roadways, and field systems, as well as to map the location of sites *vis-à-vis* environmental, geological and topographic zones.

Some researchers will likely be skeptical of a remote sensing-based investigation that does not operate in service of field survey, in the same way that many (or most) scholars remained dubious for decades about the value of regional archaeological survey except as a guide to excavation. As I have tried to make clear, dating sites based on their morphology is far from straightforward and has many limitations. It requires a robust sample of previously documented sites from the same region, and even in this case, many sites cannot be dated using this method. But these are simply issues of accuracy and certainty that are inherent in all archaeological data, and as long as we remain cognisant of these limitations, the method can be highly productive.

Similarly, the possible historical identifications I have suggested, for Tell Hajib as Irridu, Akziyaret Tepe as Pauza, and Koçlu Tepe as Waššukanni, will require further investigation. Surface survey could be used to verify or refute their dates of occupation, but certain toponymic identification would require excavated epigraphic materials. The current Syrian civil war and the resultant militarisation of the Syrian-Turkish border where all these sites are located makes it unlikely that any such evidence will be available in the near future. However, even if my suggestions about the date and identification of these sites are shown to be incorrect, it is incontrovertible that these sites are large and unusual, and thus highly significant regardless of their periods of occupation. Regional-scale remote sensing-based investigations like that undertaken here are a powerful means to make new discoveries, build new theories, and frame new questions for future research, and this is very much in keeping with the work of Tony Wilkinson. Perhaps more than any of his

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[7] Opitz's (1927) original reason to locate Waššukanni near Ras al-Ain was based on Adad-Nirari II's narrative of his fifth campaign (circa 900 BC) during which he claims to have crossed the Khabur River and headed towards Guzana (modern Tell Halaf), where he conquered a city called Sikāni. Opitz suggests that Sikāni was a derivative of Waššukanni, through the loss of an initial wa- and a shift of the second vowel from /u/ to /i/. In 1979, a Neo-Assyrian statue was found at Tell Fakhariyah that bore a bilingual Akkadian and Aramaic inscription dedicating the statue to a god, the 'Lord of the Khabur' of the city of Sikāni (Shaffer and Greenfield 1978–9; Abou-Assaf 1981), making it near certain that Tell Fakhariyah is Sikāni. However, Thureau-Dangin (1937) felt it very unlikely that 'Waššukanni' could have been transformed into 'Sikāni,' citing the fact that we already know how Waššukanni was rendered in Assyrian through the 13th century BC inscriptions of Adad-Nirari I, where it appears as 'Uššukanni'. Furthermore, the city of 'Sikān' was known by that name since at least the Ur III Period (Lipiński 2000: 120), strongly suggesting that Waššukanni must therefore be located elsewhere.

individual discoveries or methodological innovations, it was Tony's boundless creativity, forcing us to look at the archaeological landscape in ever new ways, that is his most enduring intellectual legacy and the model to which we should strive.

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Extrapolating Ebla:
Combining Remote Sensing, Survey and Textual Sources to Define an Early State

Dan Lawrence and Sébastien Rey

Introduction

The methodological revolution brought about by the systematic use of high resolution satellite imagery in Near Eastern archaeology, to which the work of Tony Wilkinson represents an unparalleled contribution, can perhaps be divided into two stages. Initially, difficulties associated with the rectification of CORONA spy photography and the prohibitive costs of high resolution modern imagery when it became available in the early 2000s restricted the spatial extent of the areas investigated. Various archaeological projects made use of both types of imagery with significant success (Kennedy 1998; Lonnqvist *et al.* 2011; Philip *et al.* 2002; Ur and Wilkinson 2008), but the actual areas covered tended to be fairly contiguous with the designated survey areas, meaning the imagery was used principally for prospection for archaeological sites and features which were to be visited in the field. The production of larger datasets was very labour intensive and generally only undertaken in institutions with large numbers of people working on similar problems, such as at the CAMEL lab in Chicago. More recently, however, increases in computer power, the development of automated or semi-automated techniques for CORONA rectification (Casana and Cothren 2008; Galiatsatos 2009) and the emergence of software platforms offering near global coverage of high resolution modern imagery such as Google Earth, have allowed for a second leap in the scale of analysis. Projects such as the *Fragile Crescent Project*, directed by Tony at Durham, the *CORONA Atlas of the Middle East* based at the University of Arkansas and the *PaleoSyr* Project based in Lyon have used these new datasets to manually map sites and features over vast swathes of the Middle East, transcending physical and geographical boundaries, environmental zones and national borders. Others have used sophisticated algorithms and combinations of satellite imagery and Digital Elevation Models (DEMs) to automatically detect locations of archaeological significance (Hritz and Wilkinson 2005; Menze *et al.* 2006; Menze and Ur 2012; although see Casana 2014 for some criticisms of these approaches in a Near Eastern context). Projects such as *ANE Placemarks for Google Earth* based at Uppsala University even make use of a form of crowdsourcing for site location. This expansion in coverage has in turn led to the construction of very large and highly complex datasets, often encompassing many thousands of sites and features identified and investigated in a variety of different ways. Intuitively, these datasets seem to represent a major step forward and yet their size and scale present significant and specific challenges which we have only recently begun to address. In order to unlock their full potential, careful consideration must be given to issues of data comparability, while the vast amount of information available requires new methods and forms of interpretation (Lawrence 2012). This paper demonstrates an approach for extracting meaning from such large datasets using site morphology as a framework and drawing in interpretations from survey and excavation data and ancient textual sources.

Site morphology and extrapolation

One of the most significant interpretive issues in understanding large-scale datasets, and in fact in archaeology in general (Plog 1974; Spaulding 1960), is how we deal with and consider time. It is almost a truism to describe archaeological landscapes as palimpsests, and yet the presence of sites and features which were not occupied simultaneously in the visible archaeological record, and therefore on the satellite imagery, is perhaps the greatest barrier to reconstructing how landscapes appeared at any given moment in the past. When locations visible on imagery can be visited on the ground this problem can be mitigated, although not entirely solved (Ammerman 1981; Bevan *et al.* 2013), by conventional survey techniques and excavation. However, the scale of landscape features often makes the latter impractical and expensive. The most common approach taken in Near Eastern survey uses the spatial association between sites, features and type fossils, aspects of material culture which have been more or less securely dated through stratigraphic excavation and radiometric dating techniques to particular periods, to assign periods. The presence of such artifacts (ceramics and lithics are the most common) at a particular location are taken to indicate an association with a particular period. In this way the overall dataset can be broken down into discrete groups of locations, or sites, based on the presence or absence of chronologically sensitive types. However, the sheer size of the datasets which we can now produce preclude complete ground-checking, notwithstanding problems of survey permissions and other issues of access, and since the sorts of material culture necessary to make temporal distinctions are rarely visible in satellite imagery, we cannot use this method to distinguish between different periods. The alternative proposed here is to scale up the process and treat archaeological sites as objects in themselves, with specific morphologies, visible on the imagery, which can themselves be chronologically sensitive. Using sites which have been securely dated through archaeological survey and excavation as type fossils, we can extrapolate to those which have not received the same level of investigation. Such an approach has been adopted in the Near East in an implicit and piecemeal way to examine highly specific and relatively isolated site types such as Sasanian fortresses (Sauer, this volume), *kranzhugel* settlements (Smith, this volume; Smith *et al.* 2014), Citadel Cities (Lawrence and Wilkinson 2015; Wilkinson *et al.* 2012), so called Irregular Clustered Structures (Philip and Bradbury 2010), and particular Mesopotamian urban defensive layouts (Rey 2015). However, this approach has not been systematically applied to a large dataset.

In order to use a specific morphology as a chronological indicator, we need to know two things; how strongly is the morphology associated with a particular period, and how much of the total settlement pattern is represented by that morphology. The first measure tells us how likely any given site which has not been visited on the ground is to date to any given period, while the second measure tells us what proportion of the total settlement system will be captured by mapping all such sites. This latter is of some importance if we want to investigate phenomena such as route networks or agricultural catchments, where the presence or absence of specific nodes is crucial to the overall pattern. We call the first measure the Occupation Likelihood (OL) and the second the Inclusivity Likelihood (IL). We can calculate the OL and IL for different kinds of sites within areas which have been subjected to archaeological survey and then extrapolate to the surrounding landscape, using the OL and IL as measures of the degree of confidence we have in the inferred settlement patterns. In the following example, we use data from the *Land of Carchemish Project*, a survey conducted in Northern Syria from 2006–2011 under the directorship of Tony Wilkinson (for overviews see Wilkinson *et al.* 2007; Lawrence and Ricci 2016).

High conical tells in the land of carchemish project

The morphology used in this example is the high conical tell. Whilst landscapes of mounded tell sites are ubiquitous across the Near East (Wilkinson 2003), the shape and size of these sites display a degree of variability. High conical tells (HCTs) are a particular class within this range which exhibit the following characteristics:

1. Prominent mounding, rising to at least five metres above the surrounding ground surface
2. Small size, generally between one and three hectares
3. Circular or sub-circular perimeter of mounded area
4. Steep sloping sides with a small flatter area at the summit

In the field this settlement type is fairly easy to distinguish (Figure 12.1) but importantly the height and steep sides also result in a distinctive signature on satellite imagery. This takes the form of a circular or sub-circular area with a lighter half, usually facing southwards, caused by the reflection of the sun's rays, and a darker half, usually to the north, caused by the shadow cast by the mound itself (Figure 12.2). The *Land of Carchemish Project* survey area included 16 examples of HCTs, representing a significant proportion of the overall settlement pattern (see Lawrence and Ricci, in press). Table 12.1 gives the OL and IL values for all of the phases used in the survey.

The phase with the highest OL value is the Middle Early Bronze Age, when 14 of the 16 high conical tells were occupied, meaning a HCT in close proximity to the survey area can be considered to have a probability of 0.88 of dating to this phase. The IL for this phase is 0.70, suggesting that mapping all such tells in the region would likely capture 70% of the total settlement pattern. Interestingly, the next highest figure for the OL dates to the Late Roman-Byzantine Period when 11 of the 16 HCTs were occupied. However, the expansion of settlement during the Classical Period resulted in many more sites away from tells (Figure 12.3). Thus although any given HCT has a relatively high chance of being settled in the Late Roman-Byzantine phase (probability of 0.69), the map of all such tells would only capture a small proportion of the settlement landscape (probability of 0.23, so 23%). The Ubaid Period presents a different problem; although all Ubaid settlements were on HCTs, giving an IL of 1.0 and suggesting that the map of HCTs would capture all Ubaid sites, the OL is relatively low (0.31), so less than a third of the tells were likely to have been occupied, rendering any such map less useful. In order to extrapolate from surveyed areas with confidence we would ideally want high probabilities for both the OL and IL.

High conical tells across the northern fertile crescent

Given their distinctive signature, it is possible to manually map HCTs across the entire study area (Figure 12.4) from CORONA imagery and high-resolution sources, resulting in a dataset of 798 sites. This is most probably an underestimation of the total number of HCTs since some may be less visible in certain physical

Figure 12.1 High Conical Tells (HCTs) in the field, Land of Carchemish Project, Syria. Top to bottom: LCP site 59, LCP site 47, LCP site 55, LCP site 60. Photographs by Andrea Ricci

Table 12.1. Occupation Likelihood and Inclusivity Likelihood values for all phases within the Land of Carchemish Project.

Phase	**Occupation Likelihood (Number of HCTs Occupied/ Total Number of HCTs)**	**Rank OL**	**Inclusivity Likelihood (Number of HCTs Occupied/ Total Occupations)**	**Rank IL**
Halaf	5/16 = 0.31	=7	5/7 = 0.71	=3
Ubaid	5/16 = 0.31	=7	5/5 = 1.00	1
Late Chalcolithic	7/16 = 0.43	5	7/13 = 0.54	8
Uruk	9/16 = 0.56	4	9/13 = 0.69	6
Early Early Bronze Age	10/16 = 0.63	3	10/14 = 0.71	=3
Middle Early Bronze Age	14/16 = 0.88	1	14/20 = 0.70	4
Late Early Bronze Age	10/16 = 0.63	3	10/15 = 0.67	5
Middle Bronze Age	6/16 = 0.38	=6	6/10 = 0.60	7
Late Bronze Age	9/16 = 0.56	4	9/10 = 0.90	2
Iron Age	5/16 = 0.31	7	5/29 = 0.17	11
Hellenistic-Early Roman	3/16 = 0.19	8	3/30 = 0.10	12
Late Roman-Byzantine	11/16 = 0.69	2	11/48 = 0.23	10
Islamic	6/16 = 0.38	=6	6/22 = 0.27	9

and environmental conditions (especially upland landscapes) and due to the variability in imagery types available. We were also relatively conservative in attributing HCT status, meaning we can be fairly certain that all of these locations are HCTs. There are clear patterns visible in the distribution, with clusters along the major rivers and in lowland basins and an absence of HCTs in the steppe lands to the south and in the gaps between the river systems, particularly between the Balikh and the Khabur. Using the method outlined above across multiple archaeological surveys we can further refine this spatially extensive dataset. Since the method relies on site numbers and types, a certain degree of homogeneity in field methods and chronological attribution within each survey is necessary to ensure comparability of results. We have used nine surveys brought together within the *Fragile Crescent Project* database which are demonstrably comparable in both regards (Lawrence 2012) and which provide a reasonable geographic coverage of the study region (Figure 12.5). Table 12.2 gives the OL and IL values for each survey for the phase with the highest OL value, i.e. when we can be most sure that a site immediately outside the area is relevant.

The phases used in the above table differ because of the level of refinement possible from survey collections in each survey. In western Syria, represented here by the AVRP and SHR surveys, the absence of well-dated and well-published excavated sequences mean the Early Bronze Age cannot be subdivided, while in the Jazira region, including the NJP, TBS and THS surveys, the same period is split into the early 3rd millennium and the late 3rd millennium. In the Middle Euphrates region, including the KHS, LCP, TSS and TS, numerous excavations carried out in advance of large dam projects allow for a tripartite division, with subtle differences between local sequences changing the exact dates that each phase can be attributed to. Despite this variety of chronological schema, it is clear that the highest proportion of HCTs across the region were occupied during the second-half of the Early Bronze Age, and particularly the period between 2500 and 2300 BC.

It is also clear that the OL and IL values vary quite significantly between surveys. These variations demonstrate the importance of spatial location in extrapolating from known surveyed sites to sites without ground checking, and this has profound implications for larger datasets. Returning to the regional HCTs dataset, we can model the likelihood of occupation during the Early Bronze Age by interpolating from the values given in Table 12.2 for all of the locations between surveys. This is accomplished using a GIS to produce a raster layer of interpolated OL values derived from the relative position of each of the surveys and then assigning the resulting values to the HCTs between the surveys based on their location to produce a regional map of OL (Figure 12.6). Empirically it was found that the regularised spline interpolation available in the *Spatial Analyst* toolbox of ESRI's ArcGIS produced the smoothest raster while retaining small-scale variability within the dataset (see Connolly and Lake 2006).[1]

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[1] Alternative interpolation techniques and weighted models,

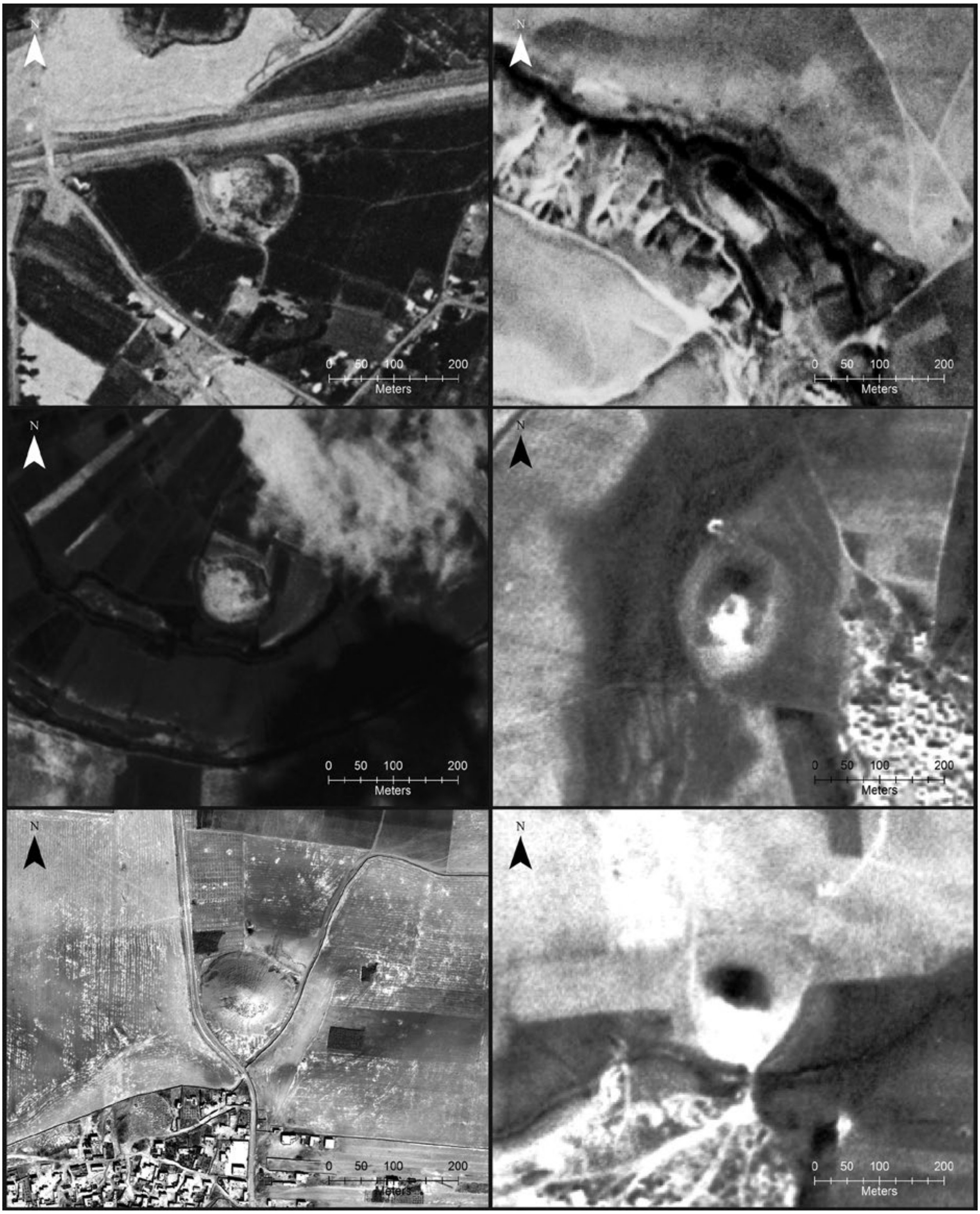

Figure 12.2 High Conical Tells (HCTs) on satellite imagery. Clockwise from top left: AVRP site 11, Corona Mission 1107 acquired 25th July 1969; TS site 30, Corona Mission 1038 acquired 22nd January 1967; LCP site 55, Corona Mission 1038 acquired 22nd January 1967; LCP site 60, Corona Mission 1038 acquired 22nd January 1967; LCP site 60, GeoEye-1 Panchromatic Image acquired 22nd September 2009; SHR site 88, Corona Mission 1110 acquired 28th May 1970.

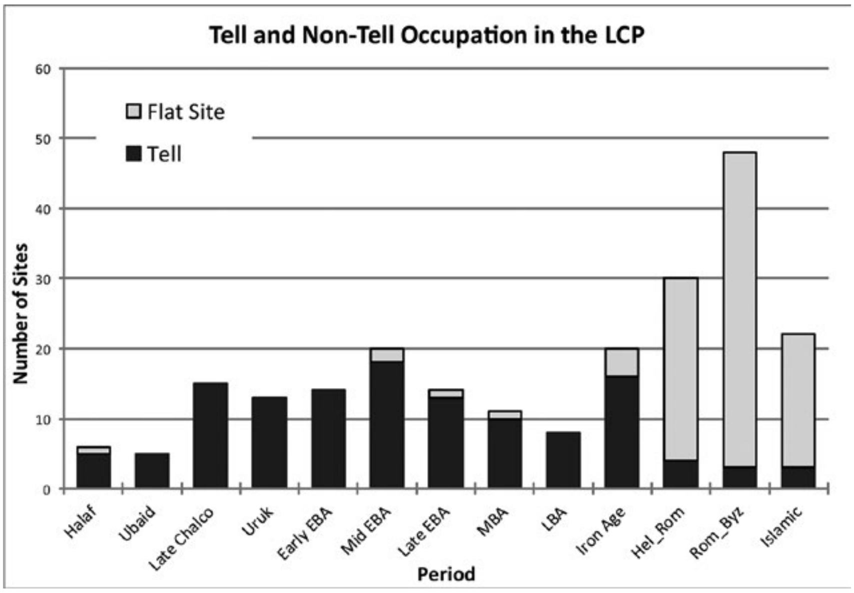

Figure 12.3 Site counts for the Land of Carchemish Project by period divided between tell and non-tell occupations

The archaeological and historical context of hcts

The map of settlement likelihood produced through the extrapolation method outlined above is itself a useful step forward, but our interpretation can be extended by bringing in archaeological and textual data.

Unfortunately, relatively few HCTs have been extensively excavated across the Near East, while the long-term occupation sequences at many of these sites make excavation a slow and complex process. However, there is a growing body of evidence which links the HCT morphology with the presence of ramparts or enclosing walls. This relationship has been articulated by Eddie Peltenburg in his discussions of the Middle Euphrates Valley, where rescue projects have resulted in the largest concentration of excavations of HCTs. On the basis of his own excavations at Early Bronze Age Jerablus Tahtani (see Peltenburg 1999), as well as others at Horum Hoyuk, Zeytinli Bahce, Şaraga Hoyuk, Shiukh Fawqani and Tell Ahmar, Peltenburg argues that the distinctive conical shape is 'due to the disproportionately robust enclosure walls embedded in the core of the mounds' (2013: 238) which hold back soil and prevent uniform erosion. We might also add EB IV Tell Qannas (Finet 1979) and EB III Tell al-'Abd (Bounni 1979) to this list — both Late Early Bronze Age strongholds (see Rey 2012) — and similar processes have been posited for HCTs in the southern Levant (Rosen 1986) and in the area around Homs in western Syria, where an exposed section revealed substantial walls at the HCT site 191 in the SHR survey (Graham Philip, pers. comm. August 2014).

The presence of walls at the sites in the Euphrates Valley allows Peltenburg to equate them with the Sumerogram BAD_3 which appears in 3rd millennium sources from both Northern and Southern Mesopotamia and which he translates as 'fortress' or 'walled entity' (2013: 238). In the Presargonic texts of Girsu, BAD_3 seems to mean a fortified watchtower, perhaps surrounded by houses (Camille Lecompte, pers. comm.). Some texts mention associated stocks of goods suggesting they could also operate as storehouses, and others seem to imply associated fields and agricultural lands (Rey and Lecompte forthcoming). Lecompte has argued that BAD_3 operates in a similar manner to an-za-gar_3 in the pre-Sargonic Period; this is of some interest here as during the Ur III Period the latter could also signify a dwelling place (Steinkeller 2007). The Sumerian an-za-gar_3 is also related to the Akkadian term *dimtum,* which has a variety of meanings including a fortified tower or dwelling, a landed estate and a fortified settlement with associated land (see Kolinski 2001: 3–5 for discussion and references). In Northern Mesopotamia, the term BAD_3 appears in texts from Ebla (Bonechi 1993: 68–69). Because these may refer directly to the area under investigation here, they are worth discussing in some detail.

Bad_3 in the Ebla Texts

The era of the Eblaite proto-Syrian archives (24th century) saw the culmination of a political system marked by the rivalry between the small Sumerian city-states and various cities and kingdoms of Greater Mesopotamia. Ebla, located in a geographically distinct area in Western Syria, was a vast kingdom controlling part of the Syrian plain and part of the Middle Euphrates, and was in competition with the urban centres of Mari, and probably Abarsal and Nagar, for control of Western Syria and Upper Mesopotamia (see Archi and Biga 2003). The age of the rival cities ended with the conquest of Sargon of Akkad and his dynasty

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including gravity models, will be discussed in a future publication.

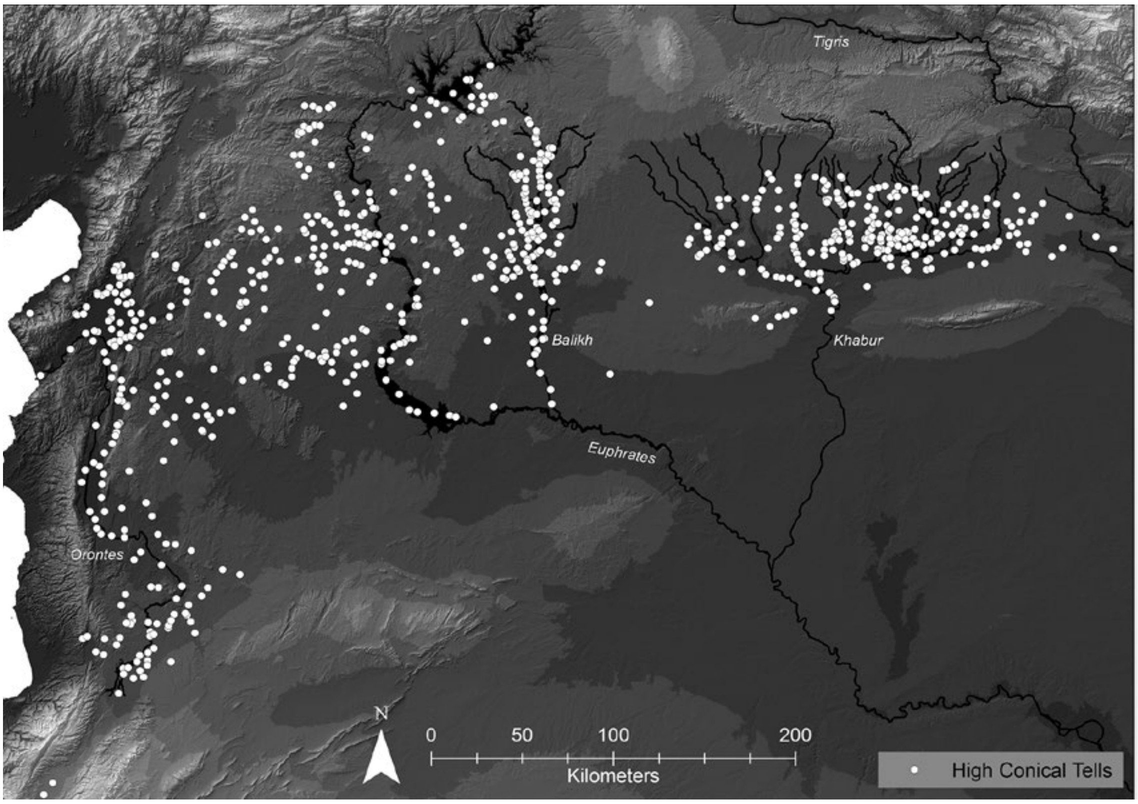

Figure 12.4 Distribution of High Conical Tells mapped for this project (N = 798)

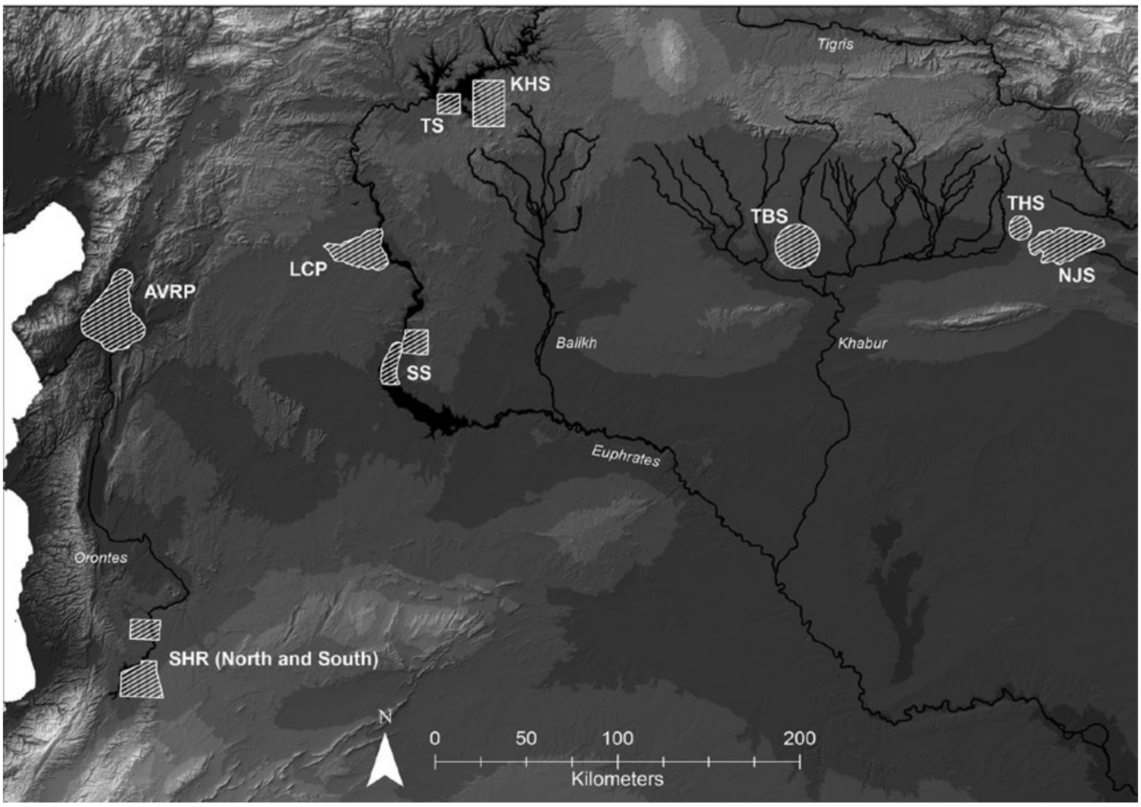

Figure 12.5 Distribution of High Conical Tells coloured by interpolated Inclusivity Likelihood (IL) values

Table 12.2. Occupation Likelihood and Inclusivity Likelihood values for phases with highest OL from nine sample surveys.

Survey Name	Phase	Approximate Dates of Phase (Years BC)	OL	IL
Amuq Valley Regional Project (AVRP)	Early Bronze Age (Undifferentiated)	3000–2000	0.76	0.65
Kurban Höyük Survey (KHS)	Middle–Late Early Bronze Age	2600–2200	0.60	0.35
Land of Carchemish Project (LCP)	Middle Early Bronze Age	2600–2300	0.88	0.70
North Jazira Project (NJP)	Late 3rd Millennium	2500–2000	0.33	0.08
Sites and Monuments in the Homs Region (SHR)	Early Bronze Age (Undifferentiated)	3000–2000	0.77	0.60
Tell Beydar Survey (TBS)	Late 3rd Millennium	2500–2000	0.78	0.68
Tell es-Sweyhat Survey (TSS)	Middle Early Bronze Age	2600–2300	0.50	0.20
Tell Hamoukar Survey (THS)	Late 3rd Millennium	2500–2000	1.00	0.50
Titris Höyük Survey (TS)	Middle Early Bronze Age	2600–2400	0.60	0.35

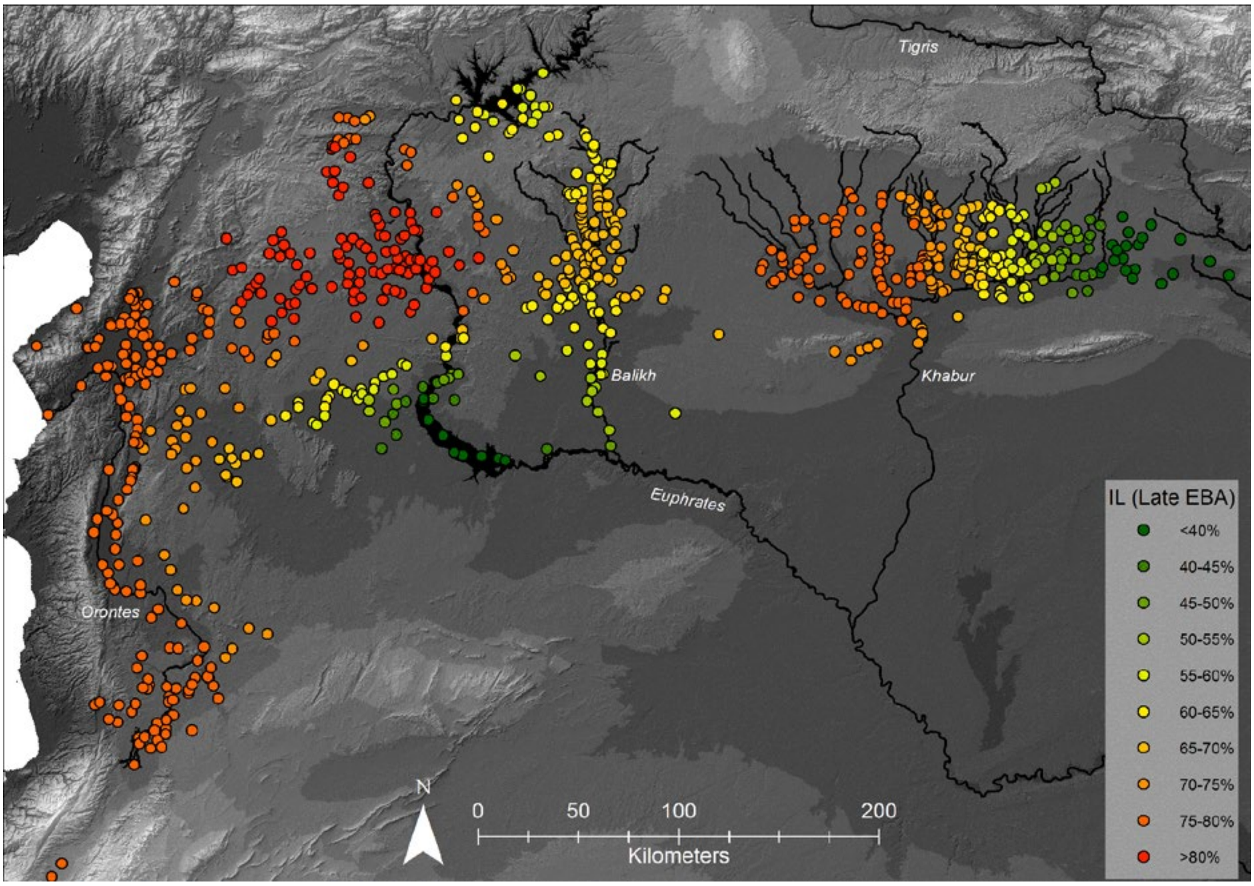

Figure 12.6 Major Early Bronze Age centres and other features with High Conical Tells coloured by interpolated Inclusivity Likelihood (IL) values

Table 12.3: Transliteration and translation of and extract of tablet ARET XIII 5 from the Ebla archive

col. i	**(§ 1)**
(§ 1)	...
1. [...]	and the / its settlements-BAD3
2. [*u*$_3$ BAD$_3$]-⌜BAD$_3$⌝^{ki}	are in the hands (belong to)
3. *in* ŠU	of the king
4. EN	of Ebla ;
5. *ib-la*^{ki}	(§ 2)
(§ 2)	Kablul
6. *kab-lu*$_5$*-ul*^{ki}	and the / its settlements-BAD3
7. *u*$_3$ BAD$_3$-BAD$_3$^{ki}	are in the hands
8. *in* ŠU	of the lord / king
9. EN	of Ebla ;
10. *ib-la*^{ki}	(§ 3)
(§ 3)	Za'ar
11. *za-'a*$_3$*-ar*^{ki}	Uziladu
12. *u*$_3$*-zi-la-du*^{ki}	and the / its settlements-BAD3
13. *u*$_3$ BAD$_3$-BAD$_3$^{ki}	are in the hands
14. ⌜*in*⌝ ŠU	of the lord / king
15. EN	of Ebla ;
16. *ib-la*^{ki}	(§ 4)
(§ 4)	Quttanum
17. *gu*$_2$*-da-da-num*$_2$^{ki}	and the / its settlements-BAD3
col. ii	are in the hands
1. [*u*$_3$ BAD$_3$-BAD$_3$^{ki}]	of the lord / king
2. ⌜*in*⌝ ŠU	of Ebla ;
3. EN	(§ 5)
4. *ib-la*^{ki}	all the others
(§ 5)	settlements-BAD3
5. BAD$_3$-BAD$_3$^{ki}	those under the control
6. *kul-a* KI	of the Lord / King
7. LU$_2$ ŠU	of Ebla
8. EN	which are under the control
9. *ib-la*^{ki}	of the Lord / King
10. *in* ŠU	of Ebla;
11. EN	those under the control
12. *ib-la*^{ki}	of the Lord / King
13. LU$_2$ ŠU	of Abarsal
14. EN	are under the control
15. *a-bar-*SAL$_4$^{ki}	of the Lord / King
16. *in* ŠU	of Abarsal.
17. EN	(§ 6)
18. *a-bar-*SAL$_4$^{ki}	Karkemiš
(§ 6)	is in the hands
19. *gar*$_3$*-gar*$_3$*-mi-iš*^{ki}	of the Lord / King
20. *in* ŠU	of Ebla ;
col. iii	(§ 7)
1. [EN]	Tinnu
2. [*ib-la*^{ki}]	and the / its settlements-BAD3

col. i	**(§ 1)**
(§ 7)	are in the hands
3. *ti-in-nu*^{ki}	of the lord / king
4. *u*$_3$ BAD$_3$-BAD$_3$^{ki}	of Ebla ;
5. *in* ŠU	(§ 8)
6. EN	Arga
7. *ib-la*^{ki}	are in the hands
(§ 8)	of the lord / king
8. *ar-ga*^{ki}	of Ebla ;
9. *in* ŠU	(§ 9)
10. EN	Ladainu
11. *ib-la*^{ki}	are in the hands
(§ 9)	of the Lord / King
12. *la-da-i-nu*^{ki}	of Ebla;
13. *in* ŠU	(§ 10)
14. EN	Darrulaba
15. *ib-la*^{ki}	is in the hand
(§ 10)	of the Lord / King
16. *dar*$_5$*-ru*$_{12}$*-la-ba*^{ki}	of Ebla ;
17. *in* ŠU	
18. EN	
19. *ib-la*^{ki}	

(2334–2193), who built an empire encompassing the whole of Mesopotamia, Mari and Ebla. In the Ebla archives, BAD$_3$ is used in a variety of contexts; here we discuss two sets of texts which shed light on the potential meaning of the term and the implications this has for our archaeological interpretations of HCTs. The first of these is the text known as the Ebla-Abarsal treaty, which terminates a series of hostilities between the two cities (see Fronzaroli and Catagnoti 2003). Since the treaty provided Ebla with control of river trade, we must assume that Abarsal was located east of the Euphrates, perhaps at Tell Chuera (see Archi 2014). The text refers to a series of cities along the Euphrates with their BAD$_3$s ‘in the hands of the king of’ either Ebla or Abarsal (see Table 12.3).

The form of this list, with BAD$_3$ associated with a particular city, suggests some relation to rural settlement as well as a political affiliation to a higher level entity, while the plural use in all cases suggests there should be a number of such sites in the landscape.

The second set of texts comprises economic documents which refer to the city of Hama on the Orontes River. Here, BAD$_3$ is used to refer to a specific type of settlement and is associated with the term UGULA or superintendent (Table 12.4). Again, the relation of the BAD$_3$ to the cities of Hama and Tubi suggest a rural setting, while there is a clear sense that such settlements were in some way affiliated to the urban centres, both in the Sumerian/cuneiform itself and in the content of the texts where goods appear to have been redistributed on that basis.

Taken together, the texts from Ebla suggest a three-tiered hierarchy of settlement organisation, in which Ebla claimed control over a series of cities, many of which retained client kings, which in turn maintained links with surrounding settlements through a system of overseers (UGULA). If the evidence from the Southern Mesopotamian sources on the meaning of BAD$_3$ is taken into account, these settlements should be fortified, while from the use of the term in the Ebla texts there should also be a large number of them in the landscape, at least in the Middle Euphrates region thought to relate to the Ebla-Abarsal treaty and in the vicinity of Hama.

Table 12.4: Transliteration and translation of extract of three tablets from the Ebla archive.

ARET III 531, f., col. iii:	
5’. 1 SAL{tug2}	1 fine cloth
6’. ḫa-lu{ki}	(for) Halu
7’. BAD3{ki}	from the settlement-BAD3
8’. ’a3-ma{ki}	(dependent of) Hama
ARET XV 38, f., col. xii :	
4 1 gu-zi-tum 2 IB2×3-SA6-GUN3{tug2}	1 specific kind of of garment
5 UGULA ka-ti{ki}	(for) the superintendent of Kati
6 BAD3{ki}	of the settlement-BAD3
7 ’a3-ma{ki}	(dependent of) Hama
ARET XIII 9 (extract)	
f.	
col. i	
1. 4 *mi-at* UDU-UDU	Four hundred sheep,
2. 40 GU$_4$-GU$_4$	40 cattle,
3. [n] *mi-at* LA-ḪA I$_3$-GEŠ	x hundred jar of oil,
4. ŠE	barley,
5. ZIZ$_2$	emmer,
6. GIG-GUN$_3$	common stained wheat
7. *a-’a$_3$-wa*	for a total of
8. 3 *li-im* GU$_2$-BAR	3000 measures gubar,
9. LU$_2$ EN	those which are of the king of
10. *si-da-ri$_2$-in*^{ki}	Sidarin,
11. LU2	those which
12. *’a$_3$-ma*^{ki}	were collected
13. IL$_2$	in Hama
14. *si-in*	for
15. BAD$_3^{ki}$ BAD$_3^{ki}$	the settlements BAD3
col. ii	
1. *du-bi$_2$*	of Tubi.

Reconstructing the landscape of Ebla

Returning to the probability map of HCT distribution in the later EBA, we can see that there is a concentration along the Middle Euphrates and in the west around Hama and north of Homs. In fact, there is a general correlation between high likelihood of EBA occupation and the extent of the Eblaite state (Figure 12.7). The boundaries of the state were likely fluid but from the textual sources and following Alfonso Archi’s reconstruction (2014) we can say that Ebla controlled Alalaḫ, and therefore the Amuq plain, and Ḫaššum, identified with Tilbeshar (south of Gaziantep) which was conquered in the early years of the Minister Ibrium. Eastward Ebla reached the Euphrates north of Karkemiš. Not far from Emar, Ebla possessed a port on the Euphrates, called MaNE. In the south, the kingdom of Ebla included Ḫamat (now Hama) and Tunip (Tell ‘Asharneh), both in the Orontes Valley, but it is still difficult to say if it reached Homs and Qatna. The recently discovered 220 km *Très Long Mur* (very long wall, Geyer *et al.* 2010), dated to the EBIV Period in the steppe region to the east of the Orontes Valley, has been interpreted by Bertrand Lafont as delimiting the extent of the Eblaite state in this region, perhaps establishing the border to the south and east of the Orontes all the way down to the Beqaa Valley (Lafont 2010). Since Byblos is not attested,[2] the border would run west along the mountains west of the valley of the Orontes. Outside of these areas, the probability map suggests HCTs are less likely to date to the EBA. In the Balikh valley, for example, there are a number of HCTs but extrapolating from the survey data suggests relatively few of them date to this period. In this case it is possible that a separate phase of rampart building, perhaps during the earlier EBA (Peltenburg 2013) or in the Middle Bronze Age (Kolinski 2001) accounts for the preponderance of this morphology. In other areas, such as the stretch of the Euphrates between Emar and Tuttul, there are hardly any HCTs. Whilst this may in part be due to the physical geography of the region, with limited areas of fertile plain suitable for cultivation and a decrease in rainfall compared to areas further north (Wilkinson *et al.* 2012), it may also reflect the region’s political significance as a contested zone between the kingdoms of Ebla and Mari.

Conclusions

In summary, we have linked together data derived from remote sensing, archaeological survey and excavation,

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[2] See however the interpretation of M. G. Biga (2014: 97–98).

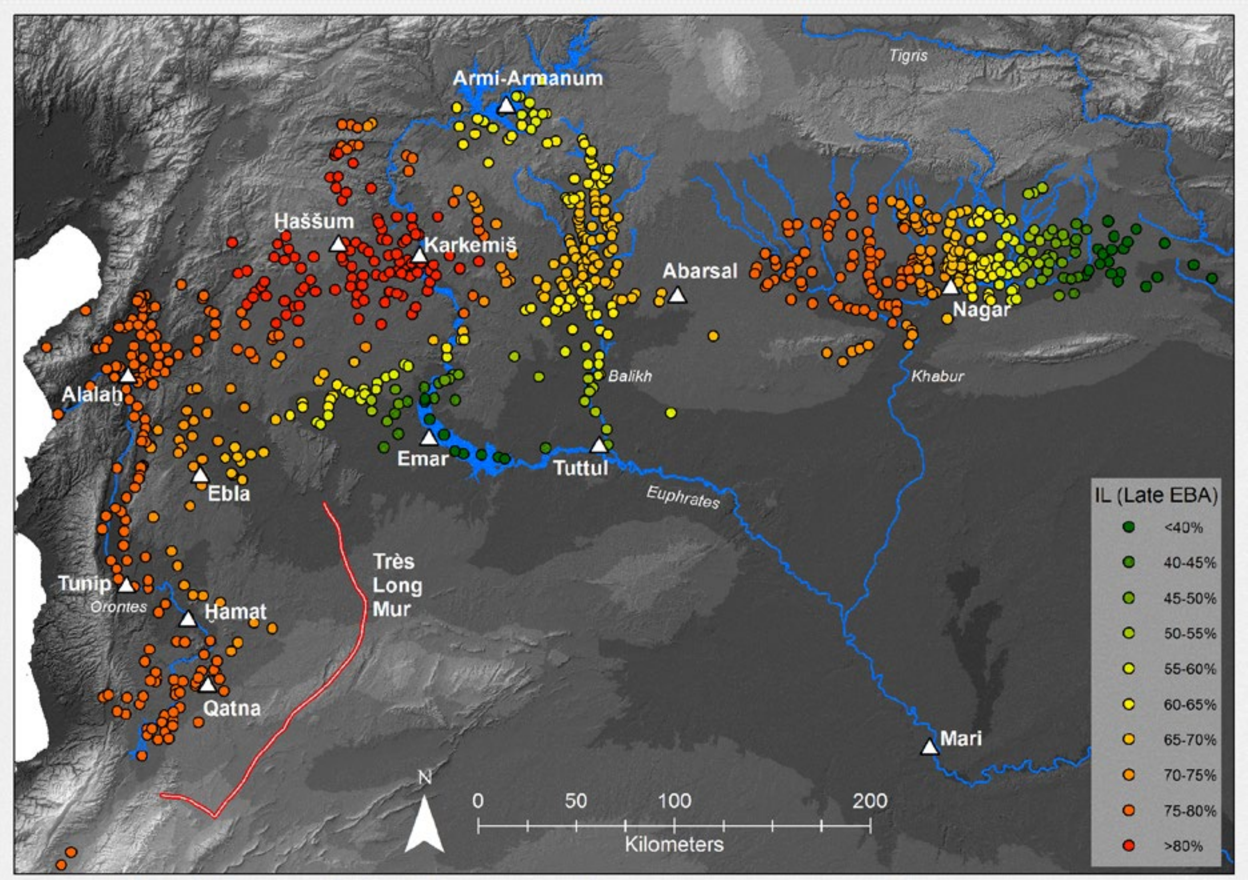

Figure 12.7. Distribution of High Conical Tells coloured by interpolated Inclusivity Likelihood (IL) values with major sites identified and including the approximate location of the so-called *Très Long Mur*

and textual sources to reach an interpretation of the later EBA state of Ebla. Mapping all HCTs through remote sensing data and then extrapolating from the survey record to make chronological predictions revealed that HCTs are not uniformly distributed in either space or time. By making two further assumptions, that HCTs retain their distinctive shape due to internal fortifications and that in the EBA these settlements can be equated to the term BAD$_3$ as it appears in textual sources, we have been able to explain some of the patterns visible in the overall settlement data. If these assumptions are accepted, the combination of data sources suggests that the Eblaite state had a particular form of territorial organisation in which land was controlled and managed through a nested system of relatively autonomous entities. Small fortified communities dotted the landscape and were managed by an UGULA or superintendent answerable to local urban elites, who in turn were 'in the hands of' the king of Ebla. Such a system would not preclude the sorts of communal land tenure arrangements hypothesised for small rural settlements during this period (see, for example, Wilkinson 2010). In fact, the mutability of these small communities would fit well with evidence for the idea of a patrimonial arrangement of ownership as a series of nested structures modeled on the household of the king (Schloen 2001).

The approach taken here, in which the morphology of individual sites is used to make predictions about their period of occupation and other traits, is a viable entry point into the sorts of large datasets we are now able to construct through satellite imagery. Interpretations made in this manner represent one of the few ways in which archaeologists can still engage with the record in areas such as Syria, where access to sites in the short-to-medium term seems unlikely. Moreover, technological innovations in remote sensing data acquisition and processing mean that our ability to recognise and define morphological aspects of sites will only increase. For example, high resolution digital elevation data derived from spaceborne synthetic aperture radar (SAR) systems such as TanDEM-X are beginning to be used in archaeology and have recently been applied in a Near Eastern context (Erasmi *et al.* 2014). Combining such techniques with large-scale composite datasets represents a fruitful new avenue of research.

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Carchemish and the Hittite Empire in the Middle Euphrates Valley

Michael Brown

Introduction

Ancient texts from Hattusa, Ugarit, Emar and Assyria attest to the importance of Carchemish during the period circa 1350–1175 BC as the principal centre of Hittite authority outside Anatolia (Cohen 2017: 300–301; de Martino 2014). In addition to this expansive diplomatic and military remit, which stretched from the Mediterranean coast to inland Syria, archaeological evidence demonstrates that the city also possessed a distinct territorial hinterland of its own. South of the modern Turkish-Syrian border this region was surveyed under the direction of Tony Wilkinson, between 2006 and 2010, as part of the Land of Carchemish (Syria) Project.

The purpose of the present contribution is to situate results from this work within the broader landscape context of the Middle Euphrates valley (see also Brown and Wilkinson 2017). This has been done by integrating all available data into a common GIS framework, in order to facilitate large-scale analysis of settlement patterns in relation to the surrounding environment. The following discussion highlights key geopolitical features pertaining to the period under review.

Information is derived from surveys and excavations, mainly undertaken since the 1970s within the salvage zone of six dams — Atatürk, Birecik, Carchemish, Tishrin, Tabqa, and Baath. These datasets are complemented by results from research projects that explore adjacent areas, including the Sweyhat (Wilkinson 2004) and Kurban Höyük (Wilkinson 1990) surveys. For spatial coverage of the main surveys used to inform the present study see Figure 13.1.[1] All sites with definite/probable (yellow) and possible (red) LBA settlement, alongside those with EIA occupation (blue) are pertinent to the following discussion (Figure 13.2). Site size provides an approximate indication of settlement hierarchy (Table 13.1).

Typological dating of constituent Late Bronze Age assemblages is often broad due to the conservative development of local ceramic technologies and general paucity of diagnostic imports. This applies particularly to those sites identified during survey and is exacerbated by the small number of C^{14} dates from excavated settlement contexts. In practice this means that it is often not possible to distinguish occupation dating specifically to LBA II (circa 1350–1175 BC), which corresponds to the historically attested period of Hittite control.

Accordingly, it is necessary to make use of written sources, in conjunction with archaeological assemblages, to provide a chronological framework by which to evaluate trends in settlement development. The expansion of permanent Hittite dominion south of the Anti-Taurus Mountains is primarily associated with the reign of two Hittite Great Kings, beginning with Šuppiluliuma I (reigned 1344–1322 BC) who conquered former Mittani territory in Northern Syria and installed his son Piyaššili (Hurrian Šarri-Kušuḫ) as viceroy of Carchemish. Hittite control over the Middle Euphrates valley was subsequently consolidated by Muršili II (reigned 1321–1295 BC). Texts from Emar and other local administrative centres provide further insights into the relationship between the Hittite authorities and vassal populations prior to the Empire's dissolution early in the 12th century BC.

It is commonly asserted that the LBA in Northern Syria and Southeast Anatolia represents a period of population decline, based on a reduction in the total number of sites when compared to the MBA. A key aim of this contribution is to question the extent and nature of this apparent trend in the Middle Euphrates valley, advocating instead for an era characterised by settlement reorganisation, as a result of overarching imperial agency. The historical implications of these developments are considered with particular reference to the changing political frontiers of the Hittite Empire in relation to its eastern neighbours.

The Land of Carchemish

A particular feature of LBA settlement is the concentration of sites along the banks of the Euphrates River. South of Carchemish the most important crossing was between Tell Ahmar and Tell Aushariye,

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[1] Adıyaman-Urfa: Özdoğan 1977; Wilkinson 1990; Algaze *et al.* 1992; also Blaylock *et al.* 1990. Birecik and Carchemish Dam: Algaze *et al.* 1994. Carchemish: Wilkinson, Peltenburg and Barbanes Wilkinson 2016; Wilkinson *et al.* 2007; Sanlaville 1985. Tishrin: Eidem and Pütt 2001; Wadi Abu Qalqal: Mottram and Menere 2005; 2008. Tabqa/Sweyhat: van Loon 1967; Wilkinson 2004. Balikh/Euphrates: Curvers 1991; Kohlmeyer 1984. West Jazira: Einwag 1993. Jabbul: Schwartz *et al.* 2000; Yukich 2013. Matah/Arid Margins: de Maigret 1978, Geyer *et al.* 2007. Queiq: Matthers 1981. Oylum: Özgen *et al.* 2001; 2002. Gaziantep: Archi *et al.* 1971; also Kulakoğlu 2006; Perrot 1962. Sakçagözü: Swartz Dodd 2007.

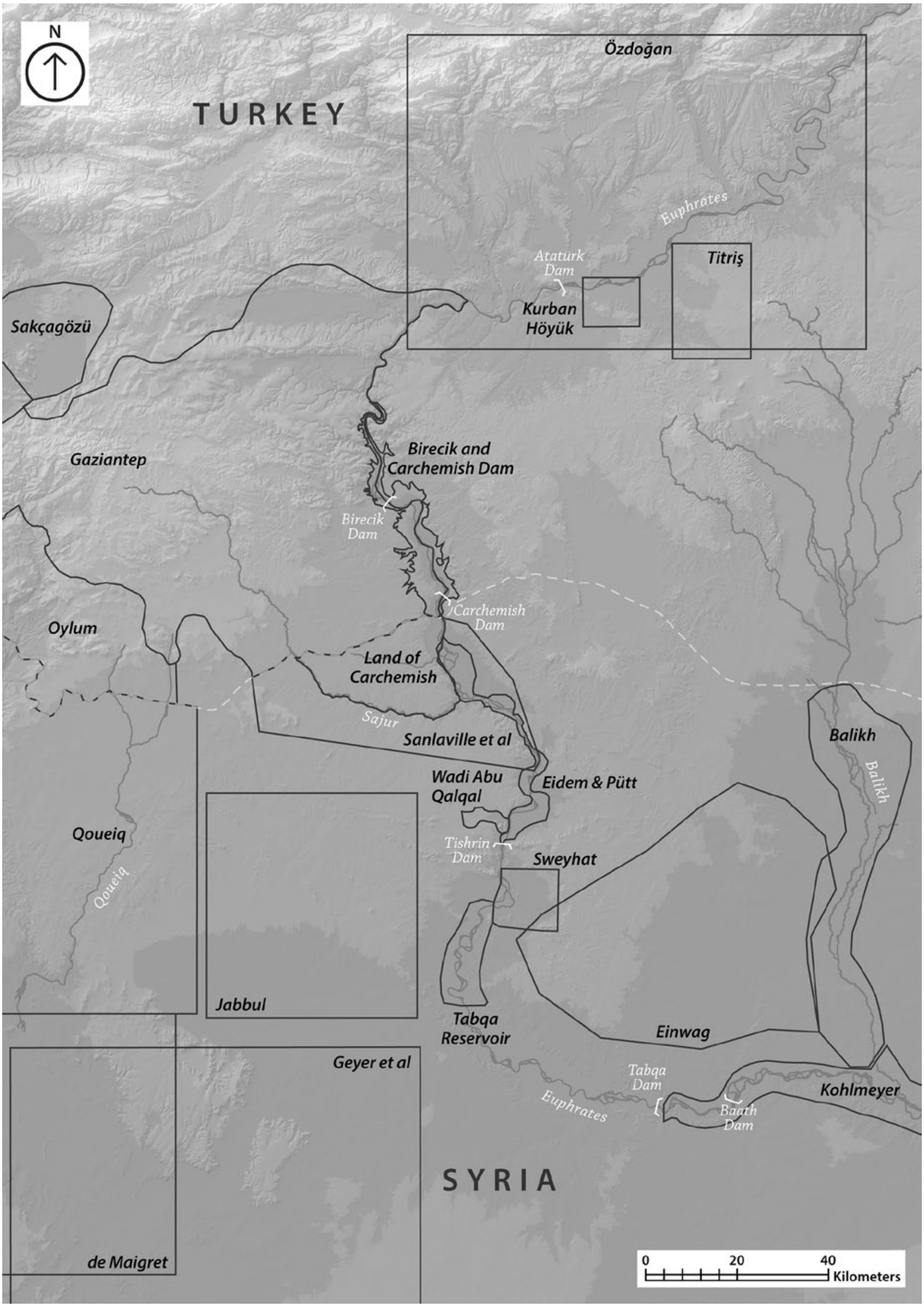

Figure 13.1. Main archaeological surveys in the Middle Euphrates Valley and adjacent regions.

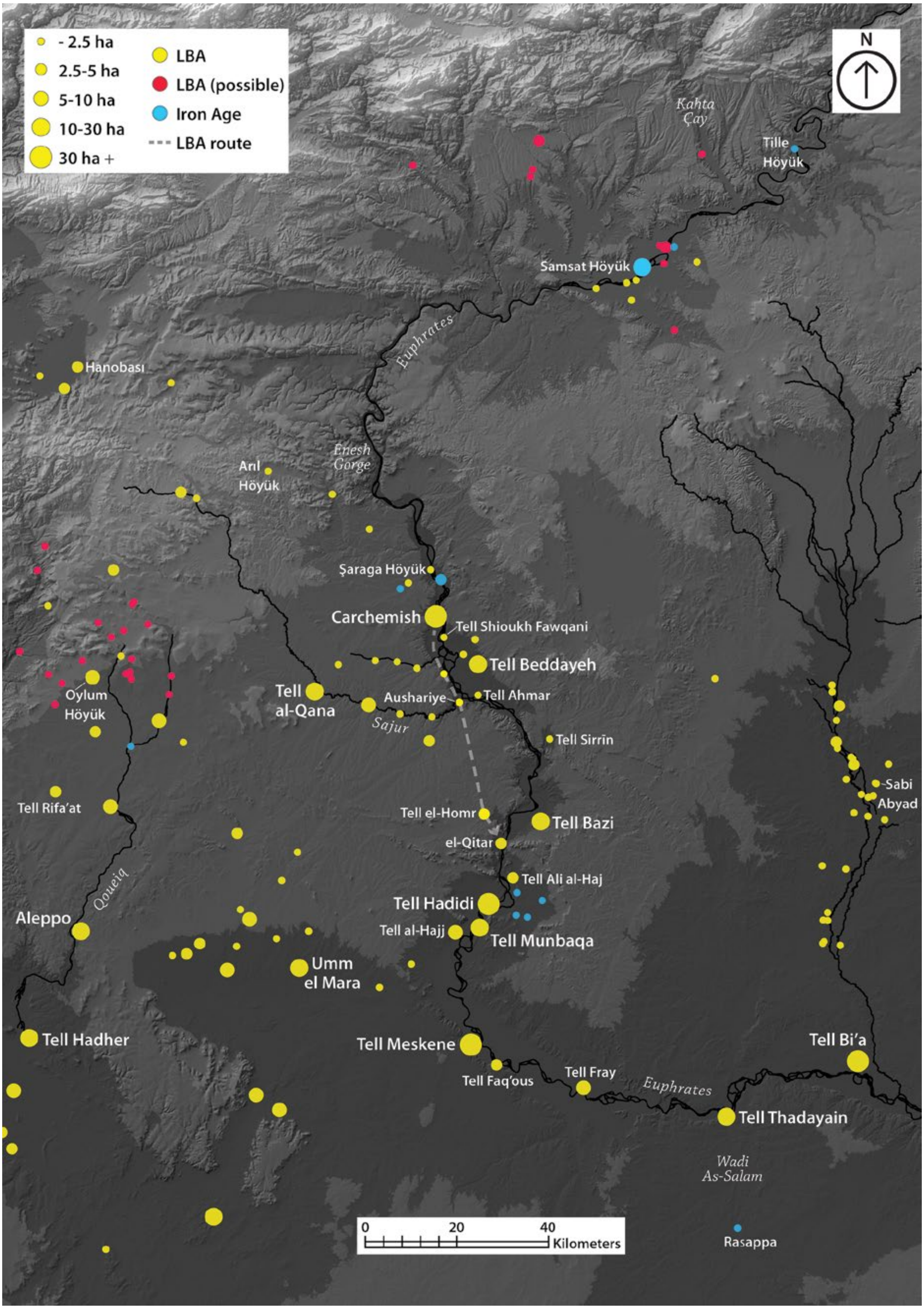

Figure 13.2. Late Bronze Age settlement in the Middle Euphrates Valley with overland communications

Table 13.1. Late Bronze Age site size estimates for the Middle Euphrates Valley.

Site name	Ancient name	Territory	Size (ha)	Site size reference
Şaraga Höyük	—	Carchemish	2.4	Algaze *et al.* 1994
Tell Beddayeh	Mutkinu?	Carchemish	10	CORONA estimate
Tell Aushariye	Pitru	Carchemish	1	Eidem 2016
Tell al-Qana	Sazabe?	Carchemish	17	Wilkinson, Peltenburg and Barbanes Wilkinson 2016
Carchemish	Carchemish	Carchemish	44	Falsone and Sconzo 2007
el-Qitar	Aštata (city)?	Aštata	3.5	McClellan 1987
Tell Hadidi	Azu	Aštata	50–60	Wilkinson 2004
Tell al-Hajj	Araziqa	Aštata	8	Wilkinson 2004
Tell Meskene	Emar	Aštata	35	Revised CORONA estimate
Tell Faq’ous	-	Aštata	3.5–4	Margueron 1982
Tell Bazi	Başiru?	Aštata	18	Otto 2006
Tell Ali al-Haj	Šumu?	Aštata	3	Wilkinson 2004
Tell Munbaqa	Ekalte	Aštata	14	Machule 1990
Tell Fray	Yakharisha	Aštata	6	Matthiae 1980
Tell Bi’a	Tuttul	Tuttul	40	Curvers 1991
Tell Thadayain	Abattum?	?	19	Kohlmeyer 1984

which is located on the west bank of the Euphrates at its confluence with the Sajur. Despite poor preservation of LBA II (Level IV) remains, Tell Aushariye does appear to have been continuously occupied throughout the Late Bronze Age.[2] The situation is less clear at Tell Ahmar on the opposite east bank, where excavations have revealed settlement pertaining to LBA I (Bunnens 2010: 117–118), together with Middle Assyrian remains dated by radiocarbon to between the 13th and 11th centuries BC (Bunnens 2009: 69). Limited evidence for intervening occupation (Stratum 7), characterised by open areas and low investment mudbrick structures favours continuous, albeit significantly reduced, use of this river crossing throughout the Hittite Period (Bunnens 2009: 68).

In the late 12th–early 11th century BC Tell Ahmar was known to the Hittites as Masuwari, and by the Assyrians as Til Barsip (Hawkins 1983). Tell Aushariye has been convincingly identified with ancient Pitru (Eidem and Pütt 2001: 86). As the only settlement of significant size located immediately east of the Euphrates with evidence for LBA–EIA occupation, the circa 10 ha site of Tell Beddayeh presents a plausible candidate for ancient Mutkinu (Figure 13.3), associated in Assyrian itineraries with Pitru and Til Barsip (Grayson 1996: 19; cf. Yamada 2011: 208).

During the first-half of the Late Bronze Age (circa 1600–1350 BC) riverside settlements also existed closer to Carchemish on the east bank of the Euphrates at Tell Shioukh Fawqani (ancient Marina) and Tell Shioukh Tahtani. C^{14} dating of the ‘Burnt Building,’ which marks the end of the LBA sequence at Tell Shioukh Fawqani, indicates that the site was abandoned in the 14th century BC (Bachelot 2005: 331), most probably concurrent with the Hittite conquest of the Land of Carchemish under Šuppiluliuma I. LBA remains at Tell Shioukh Tahtani are limited to the heavily disturbed foundations of a large mudbrick building of indeterminate date (Falsone and Sconzo 2012: 170).

North of the modern Turkish-Syrian border, the only site on either bank of the Euphrates River where LBA settlement has been recorded is Şaraga Höyük (Sertok *et al.* 2008). This is located circa 10 km north of Carchemish at the head of a wadi running from the southwest. Examples of Khabur ware, Mittani glyptic, and Luwian inscriptions indicate that the site was occupied during the first-half of the Late Bronze Age and the Early Iron Age. Lack of stratigraphic indicators for intervening destruction or hiatus suggest that Şaraga Höyük was most likely also inhabited during the Hittite Period. This interpretation receives circumstantial support through the identification of 13th–12th century BC occupation at 0.5 ha Cısırın Höyük, located circa 6 km inland along the same wadi (Algaze *et al.* 1994: 18, 52–53, 91). Early Iron Age ‘Late Hittite’ graves were also recorded

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[2] ‘The Late Bronze Age (1600–1200 BC),’ University of Copenhagen, accessed May 11, 2018, http://aushariye.hum.ku.dk/english/late_bronzeage

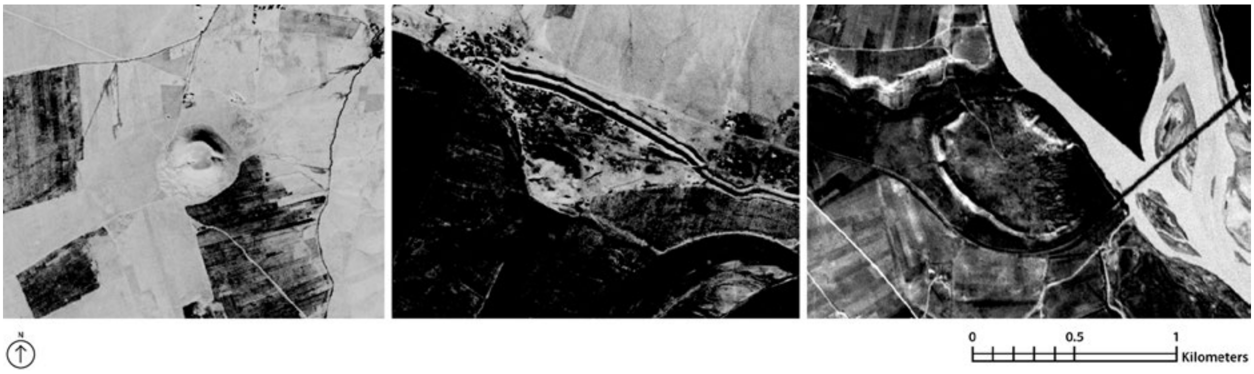

Figure 13.3. CORONA satellite imagery illustrating (left to right) Tell Beddayeh [ancient Mutkinu?]; Tell Fray [ancient Yakharisha]; Carchemish (courtesy of U.S. Geological Survey).

by Woolley (1914: 87) at neighbouring Yazir Höyük, a further 2.5 km to the southeast (Archi *et al.* 1971: 105). During the Early Iron Age, the location of Şaraga Höyük relative to Harabebezıkan Höyük, downstream on the opposite bank of the Euphrates, suggests these two settlements formed a crossing point over the river for west-to-east traffic heading towards the Suruç plain.[3] Preceding use of the western portion of this route raises the possibility that Şaraga also functioned as an embarkation point during the LBA. Further north and immediately west of the Middle Euphrates valley, probable Hittite era occupation has been identified in the vicinity of Nizip at Çirkiş Höyük (Archi *et al.* 1971: 63; Perrot 1962: 18), Turlu Höyük (Archi *et al.* 1971: 100–101; Perrot 1962: 17), and Arıl Höyük (Kulakoğlu 2006: 328).

Overall, the archaeological record pertaining to the Land of Carchemish between circa 1350–1175 BC suggests fewer crossing points over the Euphrates River and by extension reduced traffic, when compared to preceding and subsequent periods. While this apparent trend may in part be due to poor recognition of LBA II ceramic types in survey collections, excavations confirm a real occupational decline and/or hiatus in several instances. The principal historical culprit for this trend is the Assyrian invasion of Ḫanigalbat under Adad-nirari I (reigned 1295–1264 BC), and a concurrent drop-off in exchange between Carchemish and this former Hittite vassal to the east. In some respects the existence of crossing-points across the Euphrates during LBA II can be seen as a relic of an earlier geopolitical landscape, in which the emphasis was on east–west connections, as opposed to north–south links between Hittite dependent territories.[4]

West of the Euphrates LBA settlement in the hinterland of Carchemish appears to have been clustered along four valleys, with the majority of sites located on small tells (≤2.5 ha). Their seemingly equidistant arrangement can be associated with agricultural catchment along valley floors, and perhaps also defensive outposts located at strategic intervals along overland routes. The Sajur's long-standing role as a geopolitical boundary suggests this latter interpretation may apply particularly to sites between Tell al-Qana and Aushariye (Eidem 2016). Evidence for preceding MBA occupation at several sites likely reflects significant continuity in rural settlement following the Hittite conquest.

The Land of Aštata

The most densely populated sector of the Middle Euphrates valley during the Late Bronze Age was the Great Bend around present-day Lake Tabqa. This was first surveyed by van Loon (1967), and later subject to more intensive investigation by Wilkinson (2004). Numerous sites, including several important urban centres, have been excavated in anticipation of flooding. This region corresponds to Aštata, a toponym that referred to both a specific settlement and a wider territory.

Settlements in the Land of Aštata are first mentioned as Hittite possessions in the context of a treaty between Šuppiluliuma I (reigned 1344–1322 BC) and Šattiwaza of Mittani [KBo I 1]:

> '*Any cities of the Land of Aštata (on) the other bank, which are located (in) the Land of Mitanni – Igal[…],*[5] *Ahuna and Tirga — these cities of the Land of Aštata – since Prince Piyaššili with [(Prince?)] Ša[ttiwaza] crossed the Euphrates and entered Irrite — any cities on the other*

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[3] Several sites with 2nd millennium BC occupation were recorded in the Suruç plain and neighbouring Harran plain by Nurettin Yardımcı. The broad chronological resolution of these surveys as published unfortunately does not permit a reliable estimate of LBA settlement.

[4] Navigation of the Euphrates River during the pre-classical era is discussed in Fales 1993.

[5] According to Yamada (1994: 263, n. 12) the name of this city, restored as URU.*i-kál-t*[*e/á*, corresponds to Ekalte/Ikalta (modern Tell Munbaqa) in other texts.

> *bank that Piyaš[šili, (my son?)], holds, those belong to Piyaššili'* (trans. Yamada 1994: 261–262).

Explicit mention of cities 'on the (river)-bank' (Akkadian *ebertu*) as belonging to Piyaššili (alias Šarri-Kušuḫ) implies they henceforth fell under the purview of Carchemish.

The comprehensive annals of Muršili II (reigned 1321–1295 BC) later record a seemingly direct passage from Carchemish to the city of Aštata, where the Hittite Great King built a fortified citadel and equipped it with a garrison [KBo IV 4 ii 59–68] (Goetze 1933).[6] Based on the evidently defensive role of this construction, and the wider geopolitical context of increasingly hostile relations with Assyria to the east, it can be surmised that this episode most likely describes the renovation of an existing settlement on the west bank of the Euphrates. As proposed by Adamthwaite (2001: 222) the site that, arguably, best fits this description is el-Qitar, where a fortified LBA I–II settlement was excavated by McClellan (1987).[7]

Using LBA sites documented as part of the Land of Carchemish Survey, a likely route between Carchemish and el-Qitar can be inferred, passing through Khirbet Seraisat [LCP 1] and crossing the Sajur at either Tukhar Saghir West [LCP 56] or Aushariye (ancient Pitru) (Figure 13.2). Here travellers would have intersected with east–west paths on either side of the Sajur River mentioned in Assyrian campaign itineraries (Wilkinson and Wilkinson 2016).[8] South of the Sajur valley the most obvious route to el-Qitar would have been via the Wadi Membij or across the steppe, and then east by way of Wadi Abu Qalqal where LBA occupation has been recorded at Tell el-Homr (Mottram and Menere 2005).

On the east bank of the Euphrates the largest urban centre within the environs of Aštata was Tell Bazi (Otto 2006). In common with Carchemish, and its nearest neighbour el-Qitar across the river, this city comprised an upper settlement dominated by official structures including a temple, and a predominantly residential lower area. At Bazi (ancient Baṣiru?), the lower town was further divided between an older northern district, initial occupation of which predates the Hittite conquest, and the 'Weststadt,' which was a planned settlement, built perhaps a generation before the site's destruction and abandonment early in the 12th century BC (Otto 2006: 301). A prominent feature of the landscape around Bazi was the already ancient mortuary monuments of Tell Banat constructed during the 3rd millennium BC.

In contrast to riverine settlements in the vicinity of Carchemish, which were small sites positioned at 'break-of-bulk' points on long-distance overland routes, those within the Land of Aštata for the most part constituted primary urban centres in their own right. Crossing points accordingly appear to have served a predominantly local function connecting communities on either side of the river. Tell Hadidi (ancient Azu) and Tell Munbaqa (ancient Ekalte), which are both dated on historical grounds to the Hittite Period, were particularly well placed for west to east passage. Those wishing to travel in the opposite direction would have made their way to the nearest settlement north of their intended destination, in this case Tell Ali al-Haj, before crossing the river by boat. Hollow ways of probable 2nd millennium BC date, northwest of Tell Ali al-Haj and radiating from Tell Hadidi, indicate associated overland communications (Wilkinson 2004: 75, 82).

Further downstream on the east bank of the Euphrates is Tell Fray (ancient Yakharisha). For much of the period under review this site was probably located near to the eastern frontier of the Land of Aštata. Hittite control is indicated by royal seal impressions of Ḫattušili III (reigned 1267–1237 BC) and his Queen Puduhepa (Archi 1980). According to the excavator, the site was destroyed circa 1244 BC by the Assyrians (Matthiae 1980: 51). Unpublished LBA texts record the presence of a canal (Bounni 1979: 7). This was likely an earlier version of that visible on CORONA imagery, now inundated by the waters of the Tabqa dam (Figure 13.3). As noted by Wilkinson (2004: 34) the dynamic fluvial regime of the Euphrates has obscured evidence of 2nd millennium BC occupation elsewhere on the floodplain, which is known to have included fields mentioned in legal texts from Emar (Mori 2003: 98–134). This same geomorphological effect could potentially also apply to small rural settlements adjoining the river, archaeological evidence for which is similarly lacking.

Tuttul and the desert frontier

The maximum eastern extent of Hittite territory along the Middle Euphrates valley was probably defined by the confluence of the Euphrates and Balikh rivers, where the site of ancient Tuttul has been identified with Tell Bi'a (Miglus and Strommenger 2002). Tuttul later came under Assyrian ownership, probably by the second-half of the 13th century BC (Yamada 2011: 204, n. 35). Given the wider geopolitical context of empires, it is highly unlikely that Tuttul could have existed independently of a least nominal control by either the Hittites or Assyrians from the mid-to-late 14th century BC onwards.

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[6] This latter reference raises the possibility that cities in the Land of Aštata may have attempted to secede from Hittite overlordship, in common with many other vassals in Northern Syria, following the death of Šuppiluliuma I.

[7] Alternative suggestions for the city of Aštata chiefly include Tell Meskene (alias Emar; see Yamada 1994: 267 with previous literature).

[8] The site of Tell al-Qana was informally visited in 2009 during the penultimate field season of the Land of Carchemish (Syria) Project.

A significant unknown as regards the geopolitical landscape of the later 2nd millennium BC is territory along the south bank of the Euphrates. Particularly prominent within this arid and otherwise sparsely settled region is Tell Thadayain, where LBA occupation was recorded by Kohlmeyer (1984: 112). This circa 19 ha mound is located approximately midway between Tell Fray and Tell Bi'a, on the opposite bank of the river at the northern end of Wadi As-Salam (Figure 13.2).

Based on the geographic location of Tell Thadayain in relation to Tell Bi'a (ancient Tuttul), it is possible to equate the former with ancient Abattum, based upon its relative position within the 'Urbana-Yale' itinerary, which records a return journey from Southern Mesopotamia to Emar during the Old Babylonian Period (Astour 2000: 1412). In the Middle Bronze Age Abattum was the capital of the Rabbu, an Amorite group mentioned in the archives of Mari (Bryce 2009: 774–775).

Travelling south, circa 25 km, along Wadi As-Salam is the Roman site of Resafa-Sergiupolis, which can be plausibly associated with Assyrian Raṣappa. During the early 1st millennium AD this formed part of the *Strata Diocletiana* connecting the Euphrates with Palmyra and destinations further west (Konrad 2001). During the 2nd millennium BC Palmyra (ancient Tadmor) is known as a trading centre (Scharrer 2002). Passage from the Euphrates is alluded to in the annals of Tiglath-pileser I (reigned 1114–1076 BC), which cite Tadmor as the furthest point reached by Ahlamu tribesmen pursued by the Assyrians across the river (Tiglath-pileser I A.0.87.3 29–35; Grayson 1991: 37–38). It is not implausible that this remote crossing through the desert was also known to local populations during LBA II, and provided a link between the eastern and southern extremities of the Hittite empire in Syria.

Long-term trends and settlement distribution

Uncertainties about the relative dating of sites within the Middle Euphrates valley complicate attempts to understand long-term trends in settlement development. By way of example the excavator of Tell Hadidi (ancient Azu), writing at a time when the pottery sequence for the wider Great Bend region was less well known, dated that site's final phase of occupation to LBA I (Dornemann 1980). Very close similarities with ceramics from the final phase of occupation at Tell Munbaqa now suggest that these two neighbouring settlements were contemporary, and both abandoned during LBA II (Czichon and Werner 2008: 144–145). This is significant as Tell Hadidi was, based on the total surface area of its upper and lower mounds, potentially one of the largest settlements in the Land of Aštata at the time of its annexation by the Hittites (Table 13.1).

Abandonment of sites in the Great Bend region including Tell Rumeilah (Mottram and Menere 2008: 94–95) at the end of LBA I indicates a degree of synoecism which can be further linked to the (re) foundation of Emar circa 1320 BC (Finkbeiner 1999–2000: 11–14). Based on the earlier abandonment of Tell Banat and Tell Qara Quzaq at the end of the MBA, this process appears to have already been underway prior to the imposition of Hittite dominion. Reduction in the total number of sites during LBA I–II when compared to the MBA also reflects a more widespread trend evident throughout much of Northern and Central Syria. In most instances, however, lack of more detailed information regarding occupational extent makes it difficult to ascertain whether this pattern represents an overall demographic decline, versus a shift towards more nucleated settlement, which could reflect an increasing preference for fortified urbanism in an era of frequent conflict.

Differences in criteria for measuring site size also require clarification. In the case of Tell Meskene (ancient Emar) the Hittite era town was mostly excavated under the direction of Margueron (1980: 289) who states that the site covered circa 70 ha. Based on analysis of CORONA satellite imagery, this figure appears to refer to the total site catchment, including outlying fields southwest of the town proper. A more conservative estimate based on the tell alone suggests an urban area of circa 35 ha, which aligns Emar more closely with other large sites in the Middle Euphrates valley including Carchemish and Tell Bi'a (Table 13.1).

The proposed 44 ha estimate for Carchemish by Falsone and Sconzo (2007: 87) includes both the 'citadel' (4 ha), and the 'inner-town' (40 ha), which was enclosed by substantial earth ramparts (Figure 13.3).[9] These features match those described in the *Deeds of Suppiluliuma*, which record an eight-day siege of the city prior to its capture by the Hittites:

> '*on the upper citadel he let no one in[to the presence(?)] of (the deity) [Kubaba(?)] and of (the deity) KAL, and he did not r[ush] close to any [one of the temples]. (Nay,) he even bowed (to them) and then gave [.......]. But from the lower town he removed the inh[abitants], silver, gold, and bronze utensils and carried them to Hattusa and the deportees whom he brought to the palace were three thousand three hundred and thirty*' [DS, frag. 28, A iii 28–42] (trans. Güterbock 1956: 95).

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[9] A Turkish military barracks on the 'citadel' mound at Carchemish currently precludes excavation in this area. Material evidence for LBA I–II occupation in the 'inner-town' has been unearthed by a joint Turco-Italian expedition under the direction of Nicolò Marchetti (2015). Survey of the 'outer-town' as part of the Land of Carchemish (Syria) Project indicates that it was not occupied until the Early Iron Age (Barbanes Wilkinson and Ricci 2016).

This correlation allows for a reasonably secure estimate of site size, placing Carchemish at the upper end of the regional settlement hierarchy.

It should be noted that the claim of 3330 deportees sent to Hattusa, if true, represents an unknown percentage of the total number of persons removed. Based on a site size estimate for Carchemish's inner town of 40 ha, which equates to a population of 4000 to 8000 using a ratio of 100–200 persons per ha, this could mean that between circa 40–80% of the city's inhabitants (excluding the citadel) were forcibly removed. Alternatively, the abrupt abandonment of nearby settlements, including Shioukh Fawqani (ancient Marina), at the end of LBA I raises the possibility that the 3330 also includes people taken from the surrounding countryside as well as the capital.[10]

In terms of overall settlement size and composition, a stark difference is apparent between the two main geopolitical territories under review. Within the Land of Aštata several large urban centres (≥14 ha) co-existed in close proximity at Emar, Bazi, Munbaqa, and probably Hadidi. By way of contrast Carchemish dwarfed other settlements in its hinterland, that with the exception of Tell al-Qana and Tell Beddayeh all covered 3 ha or less.[11]

Concentration of Hittite era sites along the Middle Euphrates valley around Carchemish, Aštata, and Tuttul is made more conspicuous by the apparent absence of contemporary occupation in many adjoining regions (Figure 13.2). For some areas this differential distribution very likely reflects, at least in part, gaps in the archaeological record due to limited survey coverage. In other cases it was clearly environmental factors, exemplified by mountainous terrain west of Gaziantep, which constrained settlement development. Through combined analysis of archaeological and written sources it is also possible to associate absence of occupation during the Late Bronze Age with specific geopolitical circumstance.

West of Aštata is the Jabbul plain. Results from survey in this region by Schwartz *et al.* (2000: 451–452) indicate relatively low LBA occupation when compared to the preceding MBA (see also Yukich 2013). A decline in overland trade passing through the Jabbul plain between Aleppo and the Middle Euphrates valley potentially relates to the concentration of political power at Carchemish concurrent with Hittite rule, and an associated shifting northward of overland communications in favour of the Sajur valley. Development of the fortified LBA–EIA town at Tell al-Qana (ancient Sazabe?) can also be linked to the increasing importance of this route. A clear correlation is apparent between the distribution of rural sites northwest of Umm el Mara (ancient Tuba; Figure 13.1), and the zone of stable rainfed agriculture as defined by the 300–250 mm isohyet.

North of Carchemish the city-kingdom's hinterland was naturally truncated by the Enesh gorge. In the adjoining Adıyaman basin, several distinct ceramic assemblages have been attributed to the Late Bronze Age by Özdoğan (1977). Higher up in the mountains some small mounds with possible later 2nd millennium BC occupation were noted by Burney (see Russell 1980). East of the Euphrates, sites with probable LBA occupation have been recorded as part of the Kurban and Titriş Höyük Surveys (Algaze *et al.* 1992; Wilkinson 1990).

Most recently, revised C^{14} and dendrochronological dating for Tille Höyük, which provides the primary reference sequence for survey in the Adıyaman basin by Blaylock *et al.* (1990), imply that the area below the Anti-Taurus Mountains and west of the Euphrates was devoid of settlement during the Late Bronze Age (Summers 2013). While this apparent absence is very likely due, at least in part, to uncertainties regarding ceramic typologies, the Adıyaman-Urfa region nonetheless appears to have been severely depopulated when compared to more southerly sectors of the Middle Euphrates valley.

This restricted pattern of occupation could theoretically be related to conflict between the Hittite and Mittani empires during the first-half of the Late Bronze Age, when settlement in the Adıyaman plain would have been vulnerable to attack by either party due to its seasonally isolated location. Close communications between the Urfa region and the Mittani heartland of the upper Khabur watershed (ancient Ḫanigalbat) have previously been noted by Wilkinson (1990: 6).

The Bronze Age collapse

The main casualty in the Middle Euphrates valley of the settlement disruptions that characterise the end of the Late Bronze Age throughout much of the Hittite Empire and beyond was undoubtedly the Land of Aštata. All the region's major urban centres were abandoned, and Tell Munbaqa (ancient Ekalte) is apparently unique in not displaying evidence for conflagration at this juncture (Otto 2006: 20). This cataclysm contrasts with the situation immediately prior, when the construction of the Bazi 'Weststadt' suggests a degree of regional prosperity under Hittite rule. Further downstream, Tell Bi'a (ancient Tuttul), now under Assyrian control, also seems to have become abandoned around the same time.

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[10] Deportation of persons captured in battle by the Hittites is discussed in Hoffner (2002).

[11] The relative distribution of small rural sites is less clear due to the possible obscuration of 2nd millennium BC settlement on the Euphrates floodplain around the Great Bend.

When considering the fate of Aštata, and possible culprits for its demise, it is worth noting the repeated claim by the Assyrian King Tukulti-Ninurta I (reigned 1233–1197 BC) to have deported 28,800 people from west of Euphrates back to Aššur (Grayson 1987: 271–276):

> '*At the beginning of my sovereignty (lit. at the beginning of the throne of my sovereignty) … I uprooted 28,800 Hittite people from Syria (lit. 'Beyond the Euphrates') and led (them) into my land.*' [Tukulti-Ninurta I, A.0.78.23 27–30/A.0.78.24 23–24]

Contemporary texts from Emar also record a major 'Ḫurrian' incursion into the Land of Aštata during the late 13th century BC (Emar VI 42.9/RE 77.34/ASJ 12–T 7.29/TS 9.21), most likely by the Assyrian satellite kingdom of Ḫanigalbat, which resulted in the temporary seizure and occupation of Araziqa (modern Tell al-Hajj; Yamada 2011: 210–212, 205–206). An initially devolved conflict between Carchemish and Assyrian Ḫanigalbat, subsequently taken up by the Great Kings of Hattusa and Aššur, may explain the otherwise conspicuous omission of this episode from royal texts dating to earlier in Tukulti-Ninurta I's reign (1233–1197 BC).

Assyrian campaigning under Tukulti-Ninurta I is also too early to account for the final destruction of Emar itself, which is independently dated on historical grounds to circa 1175 BC, shortly after the dissolution of the Hittite Empire (Cohen and Singer 2006: 134). If Tell Meskene (ancient Emar) is excluded, leaving a combined settlement area of circa 111 ha for the Land of Aštata based on the site size estimates listed in Table 13.1, then 28,800 deportees would equate to circa 259 persons per ha. Although higher than the usual 100–200 persons/ha range, this figure is not unrealistic for densely populated cities in the ancient Near East (Pedersén *et al.* 2010: 122).[12]

Such a large-scale deportation from further north in the Land of Carchemish seems highly unlikely, based on the evident continuity in settlement and societal development across the Bronze to Iron Age transition (Brown and Smith 2016; Hawkins 1995). The Adiyman-Urfa region can similarly be discounted due to its already diminished population. It should be noted that significant uncertainties remain regarding the relative timing of settlement abandonments in the Great Bend region based on archaeological evidence.

The only indication for continuing settlement in the former territory of Aštata comes from survey, with probable Early Iron Age occupation at Tell Ali al-Haj (Wilkinson 2004: 189). This potentially correlates with texts that record the (re)building of Šumu (mar VI 15/RE 70.28), a city situated in the vicinity of Emar, following the aforementioned 'Assyrian' conquest (Yamada 2011: 212). Limited Iron Age occupation nearby around Tell Sweyhat, which appears to respect pre-existing land tenure arrangements, is tentatively associated with long-term use of the area by semi-nomadic pastoralists (Wilkinson 1995: 150).

Practical arrangements made by the Assyrians for deportees, who were sometimes transported by boat, are discussed in Oded (1979: 33–40). As regards the destination of persons taken from 'beyond the Euphrates,' one possibility is that they were resettled in Kar Tukulti-Ninurta, a large urban centre located near Aššur, construction of which began at approximately the same time as the alleged mass deportation (Gilibert 2008).

Conclusions

Hittite era settlement in the Middle Euphrates valley can be divided into three main sectors: Adiyaman-Urfa, Carchemish, and Aštata-Tuttul. Each of these represents, in chronological succession, a landscape transformed by overarching imperial agency.

Beginning in LBA I with the northernmost Adiyman-Urfa sector of the Middle Euphrates valley, this region appears to have become depopulated, plausibly as a result of conflict between the Mittani and Hittite states. When the Hittites extended their control beyond the Anti-Taurus Mountains during the later 14th century BC, the Land of Carchemish was irrevocably altered by large-scale deportation, and realignment of long-distance communication routes.

At the end of the Late Bronze Age wholesale destruction and abandonment of the Land of Aštata represents one of the most dramatic examples of population displacement anywhere in the ancient Near East. As suggested above, the chief suspect (complete with written confession!) for this mass uprooting of population is the Assyrian Empire. This episode brought to an end a distinct regional tradition of urbanism stretching back to the 3rd millennium BC (Cooper 2006; Wilkinson *et al.* 2012). While the number of deported persons recorded in many ancient texts was undoubtedly apocryphal, serving a propagandistic as well as documentary purpose, the close correlation between archaeological and historical evidence pertaining to the Land of the Aštata raises the possibility that such claims were also, on occasions, broadly accurate.

Limited chronological resolution of survey data precludes attributing occupation in many areas of the Middle Euphrates Valley specifically to LBA II.

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[12] The hypothetical addition of small rural sites on the Euphrates floodplain, subsequently eroded and/or buried beneath alluvium, would also mean a lower ratio.

The importance of both Hittite and Assyrian agency for determining settlement landscapes is nonetheless clear through combined analysis of archaeological and written sources. Although the overall number of Late Bronze Age sites fell when compared to preceding periods, the era of Hittite control was also associated with significant urbanisation projects. This trend is most pronounced around the Great Bend at sites including Tell Bazi, el-Qitar, and Emar, and is especially notable given their location within the 'zone of uncertainty' beyond the southern limit of rainfed cultivation.

In more general terms the Middle Euphrates valley can be characterised as a frontier zone, on the periphery of rival empires to the east and west, from which local populations were repeatedly removed under the threat or force of arms. By the first-quarter of the 12th century BC Carchemish constituted an island of settlement within an otherwise sparsely populated landscape. Only 25 years previously it had, by virtue of its links with Hattusa, been at the political centre of a vast imperial network encompassing much of inland Syria, Southeast Anatolia and the Northern Levantine seaboard.

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Land of Behemoths:
Re-Casting Political Territories of the Middle Bronze Age Jazirah

Rune Rattenborg

Introduction

The constituent elements of early state formation form a key object of study in various strands of Ancient Near Eastern research. Though still a formative element in current debates, theories of early states have come a long way from the monolithic power structures resident in functional and organismic frameworks of neo-evolutionary theory, towards notions of resilience, heterarchy, differentiation, and socio-spatial variability (Stein 2007; Yoffee 2004). The return of historic approaches to the traditional framework of social evolution, with their emphasis on historical particularity within the greater trajectories of human society, provides for a comparable broadening of analytical dimensions in the understanding of social change (Pauketat 2001).

These developments have not gone unheeded in landscape archaeology, where a stream of multi-disciplinary perspectives, incorporating survey, excavation, and historical source material, has brought about a proliferation of new insights on the workings of political structure within the cultural landscape. The vast expanses of data on past settlement patterns across the Fertile Crescent now available to us, owing especially to the work of Tony Wilkinson and others, offer a framework for the analysis of early complex societies in the region hardly imaginable a few decades ago (e.g., Wilkinson *et al.* 2013; 2014).

The integration of textual and archaeological data on a regional scale represents a promising, though more inchoate aspect of these investigations. The shaping of analytical perspectives sensitive both to the minute detail of historical information and the concurrent *longue durée* of the archaeological record is certainly one of the most intriguing fields for future research, and not without contradictions to overcome (as aptly demonstrated in Casana 2012). The present study aims to further such perspectives, through a comparative study of the manifestations of territorial states on a local level as evidenced in various genres of cuneiform sources.

Looking to the present, concepts of state have been strained by numerous developments since the end of the Cold War and the intellectual overhaul of perceptions borne by the nation-states of the 19th and 20th century CE (e.g., Abrams 1988). Though the state may still be considered a systemic necessity for the study of social order by some (e.g., Fukuyama 2011), recent events, such as the US War on Terror, have laid bare a much more dynamic dialectic between political territory, power, and coercion (Elden 2009). The multitude of state agents involved in asymmetrical warfare in developing nations, semi-privatised drone attacks, and grey areas of territorial dispute and frozen conflict are all instances that serve to illustrate how the state of the 21st century CE has moved, and is constantly moving, beyond any neatly devisable lines on a map, if such could ever have been drawn.

These developments hold important, if not crucial, implications for the study of past societies in general, and for the models currently employed in our analysis of early state formations in particular, in that they challenge long-held assumptions about the constituent elements of states as these have come to be perceived in traditional discourse. In a recent essay, Scheidel emphasises the dynamism of territorial aspects in Weber's classic definition of the state, drawing attention to the fluid and non-contiguous spatial configuration of political power, readily associable with the, often vague, territorial outlines of early states (Scheidel 2013: 5). Mann employs a similarly loose outline, balancing the emphasis on territoriality as an element of political organisation with a cautionary disregard for static notions of societal organisms and clearly delineable zones of control, thereby situating the state in a dynamic socio-spatial frame of analysis (Mann 2012 [1986]).

Territoriality and political power, and the dialectic relationship between the two, has been the subject of recent theoretical discussions in archaeology and anthropology also (see VanValkenburgh and Osborne 2012 for a recent overview). In a thought-provoking work, Smith argues against the common perception of political power as confined to a uni-dimensional realm, either succumbing to or overcoming comparative agents encountered in an absolute physical space. Such notions in fact confuse political power with the reified sense of authority that we have come to attribute to states as a consequence of their contemporary formal outlines (Smith 2003).

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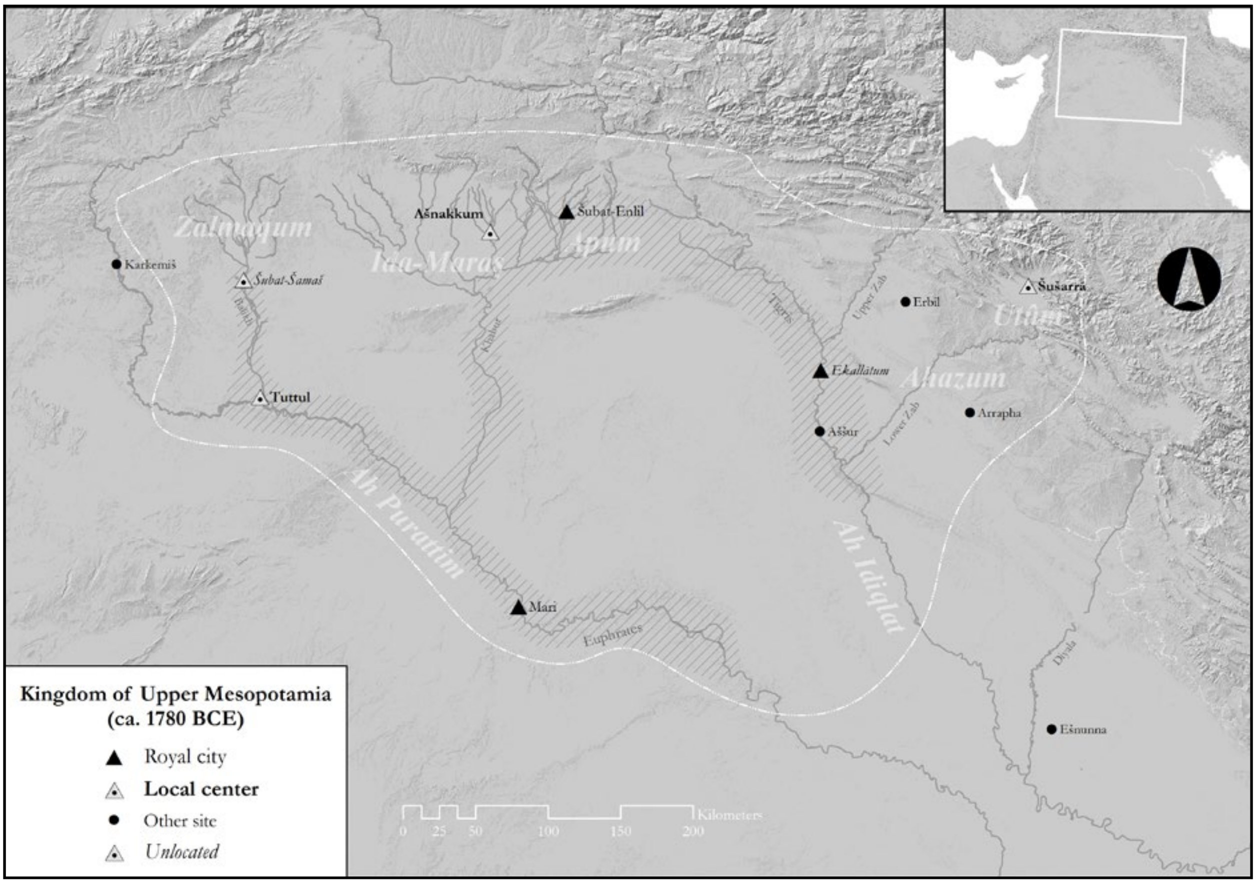

Figure 14.1. Map of the Kingdom of Upper Mesopotamia, with principal settlements mentioned in the text. Also given is an approximate maximum territorial extent (dashed line) and core areas (grey hatched).

Emergent trends toward a differentiation of political space can be seen also in the study of polities of the Ancient Near East. Several contributions on the political structure of the Neo-Assyrian Empire address the dynamism and conflict between social structures and state power and emphasise the role of a multitude of different socio-spatial factors (Bernbeck 2010; Liverani 1992; Parker 2001; 2012; see for the Late Bronze Age and early Iron Age also Brown 2013; Cancik-Kirschbaum *et al.* 2014; Casana 2012; Liverani 2001; Osborne 2013). A number of authors have touched on similar notions with regards to patterns of political practice in the Middle Bronze Age Jazira, more specifically in the apparent intersection of several political spheres of influence in the dry-farming plains of Northern Syria and Iraq (Eidem 2000; Meijer 2000; Ristvet 2008; 2012). Rather than presenting us with neatly devisable borders and molecularly organised zones of political control, entities here appear to orient themselves along the lines of complex and interspersed political networks.

I propose here to investigate and expand upon these perspectives through a review of the spatial correlates of political power observable within the Kingdom of Upper Mesopotamia, an early territorial state of the Middle Bronze Age (circa 1808–1776 BCE).[1] This is attempted through the discussion of economic organisation and associated social infrastructures of administrative and political control as evidenced in cuneiform corpora from three locations: Tall Šimšāra (or Shemshara), ancient Šušarrā, on the Lesser Zab River in present-day Iraq, Tall Šāghir Bāzār (or Chagar Bazar), ancient Ašnakkum, in the Khabūr Basin of northeast Syria, and Tall Bī'a, ancient Tuttul, on the Syrian Euphrates (Figure 14.1).

Juxtaposed with political correspondence, chiefly from Mari (Tall Harīrī), this material presents us with a rare sample of documentation on the economic organisation of multiple local institutional households, all of which have been traditionally conceived of as encompassed by the authority of an early territorial state. The Kingdom of Upper Mesopotamia finds common mention in numerous studies of early states of the Ancient Near

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[1] Absolute dates follow the Middle Chronology as given in the Revised Eponym List (REL) presented in Barjamovic, Hertel and Larsen 2012. Though readers should take note of current discussions as to the ordering of individual year names (e.g., Charpin and Ziegler 2014), I employ absolute years in agreement with the REL for ease of reference, and because said issues do not critically impinge on the arguments advanced here.

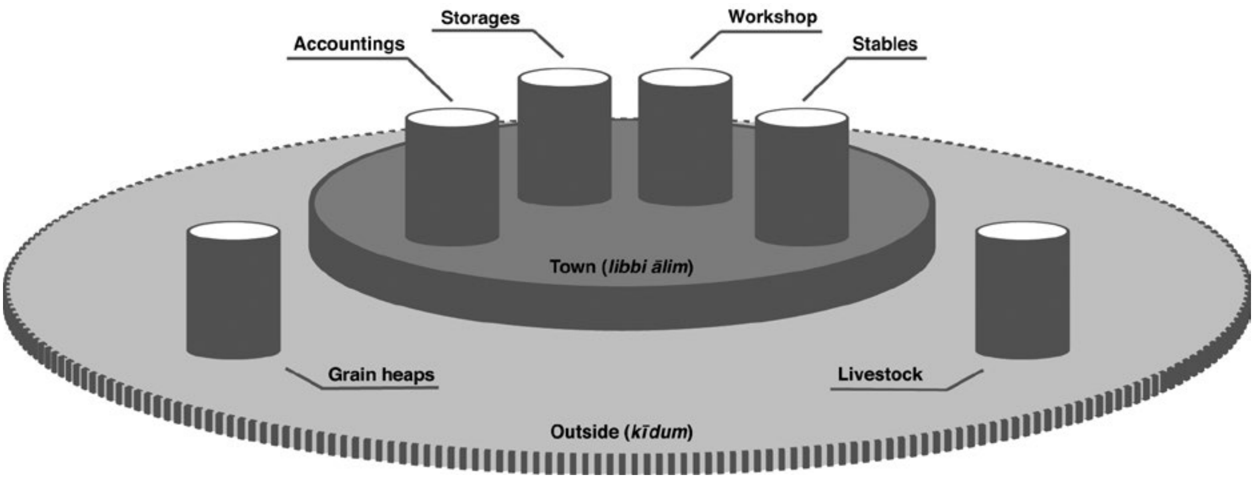

Figure 14.2. Schematic representation of managerial outline given in ARM XXVI/2 300, with principal managerial units.

East (e.g., Barjamovic 2013: 129–137; Trigger 2003: 104–119). Preceded by the late 3rd millennium empires of Akkad and Ur, it constitutes one of the early departures from a political landscape comprised of individual city-states that form the traditional node of political power in Bronze Age Ancient Near Eastern society. A detailed historical account of the reign of Šamšī-Addu and the formation of his kingdom exceeds the scope of the present paper, and the current state of knowledge has been excellently summarised in full elsewhere (e.g., Charpin 2004). Suffice to say that, at the height of its power, the kingdom spanned the plains and dry steppe from the Euphrates Bend in the west to the Zagros piedmont in the east, with core areas around the city of Mari in the Syrian Euphrates Valley, Ekallātum on the Middle Tigirs, and Šubat-Enlil in the Khabūr Basin. The kingdom deteriorated abruptly in 1776 BCE following the death of Šamšī-Addu.

Local economies, regional polities

All of the three administrative corpora considered here are of a largely synchronic date and fall within a timespan of less than two decades in the latter part of the reign of Šamšī-Addu. While Šušarrā entered only briefly into the realm of the kingdom in the year of Aššur-malik (1781 BCE), Ašnakkum and Tuttul both constituted urban centres within core areas of the state territory. In reviewing select elements of this documentation, I focus here on the scale and management of basic assets, such as agricultural produce and livestock, at a local level, and the degree to which the management of these assets can be deemed integrated with regional political networks. This analysis is based then on the reconstruction of local economic organisation, and the socio-political contextualisation of administrators and officials related to these activities. In conclusion, it is argued that such an analysis will enable us to discuss the relationship between local institutional economies on the one hand, and the echelons of a regional state polity and its principal authorities on the other.

To offer an exemplary framework for addressing these questions, let us briefly consider an illustrative letter contemporary with the textual records under discussion. It relates to the management of a royal estate in the city of Ekallātum (cf. Heimpel 2003: 288–289; Villard 2001: 56).

> ‘(…) Mašiya is to supervise outside affairs, the field, the plows, (and) the grain heaps. This he should supervise in addition, and he is the one who does the accounts. Uṣur-awassu is to supervise affairs inside the city, the storages, the accountings office, the craftsmen, the [*workshop*], and the fattening house. (…)’ ARM XXVI/2 300 l. 9‘–19‘[2]

In conceptual terms, this excerpt offers for a basic ordering of principal managerial elements of institutional households largely in agreement with the individual corpora of administrative documents considered in the following. While the former group overseen by Mašiya encompasses agricultural units and grain stored in the countryside, to which we may add livestock and draft animals, the latter, overseen by Uṣur-awassu, concerns principal storage, administration, craftsmen, workshops, and fattening house (see Figure 14.2). Organisationally, these different areas were attended to by smaller units, for example farming teams, work gangs, groups of servants, and the like, often overseen by a named individual, who would

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[2] ARM XXVI/2 300: (9’) $^{\text{I}}$*ma-ši-ia* *ṭe*$_4$*-em ki-di-im* (10’) a-šà $^{\text{giš}}$apin-hi-a (11’) *ka-re-e li-wa-e-er* (12’) *an-né-e-em a-na wa-tar-ti-*[*im*] (13’) *li-wa-e-er* ù šu-*ú-ma* (14’) *e-pí-iš ni-ka-as-*[*sé-e*] (15’) $^{\text{I}}$*ú-ṣu-ur-a-wa-a*[*s-sú*] (16’) *ṭe*$_4$*-em li-ib-bi a-lim na-ka-m*[*a-tim*] (17’) [*é t*]*e-er-tim* dumu-meš *um-me-n*[*i*] (18’) [*ne-pa-r*]*a-am* ù é *ma-ri-*[*i*] (19’) [*li-wa*]-[*e-er*]

figure on records of maintenance allotted to this unit by various institutional storages.

By reviewing textual sources from three different local institutions in light of this conceptual framework, it will be argued that whereas the managerial structure of economic assets at a local level abides by comparably similar organisational outlines, the nature of interaction, in a political and economic sense, between these local institutions and the upper echelons of the Kingdom of Upper Mesopotamia varies markedly.

Such an assertion is of considerable relevance to regional archaeological discussions of early political landscapes as it highlights the need for dynamic approaches to socio-spatial variability in the analysis of economic and political structure. As will be demonstrated here, the relations of political power and material organisation should be assumed neither concurrent nor static, especially not within a territorially extensive political entity. To start at the extreme periphery, let us turn to the first case.

The Zagros Piedmont: Šušarrā

Excavations at Tall Šimšāra, located in the Rania Plain of the Lesser Zab Valley, were carried out by the Danish Dokan Expedition in the spring and summer of 1957. Excavations retrieved a substantial body of cuneiform texts, comprising just more than a hundred letters and forty administrative texts. This group was supplemented by the unearthing of a separate group of administrative texts, 107 in total, by Iraqi archaeologists in 1958 (for a detailed overview, see Eidem 1992: 11–15, supplemented by Eidem and Læssøe 2001: 13–16). The two groups of administrative texts concern different managerial aspects pertaining to the institutional household of Kuwari, headman of Šušarrā, while the letters are primarily concerned with regional political matters and offer sparse light on local economic affairs. Kuwari apparently acted as the local associate of the kingdom of Itabalhum, a polity located further east in the Zagros Mountains, and oversaw holdings in the land of Utûm, a region likely corresponding to the Rania Plain around Šušarrā.

We know preciously little about the land of Utûm in the centuries preceding the archives of Kuwari, but haphazard evidence indicates that common administrative practices may already have been present in this part of the Lower Zab Valley during the late 3rd millennium (Eidem 1992: 9), while recent excavations have also attested to such practices in the early 2nd millennium (Eidem 2013: 11).

Šušarrā came under the control of Šamšī-Addu only briefly, in the course of the king's joint campaigns with the kingdom of Ešnunna in the years of Asqūdum and Aššur-malik (1782–81 BCE). Faced with potential conquest, Kuwari apparently shifted his allegiance and continued to rule the city as a vassal, perched on the outermost border of the realm facing the gates to the Iranian plateau. Following Eidem's reconstruction of events, Kuwari's association with Šamšī-Addu was short-lived, as his city fell prey to a revolt less than a year later. This revolt also marked the end of engagements in the Zagros foothills for Šamšī-Addu (Charpin and Ziegler 2003: 95–107; Eidem and Læssøe 2001: 16–63).

In conjunction with the political landscape evinced by the letters, the administrative texts offer valuable outlines of the institutional household overseen by Kuwari. Though fragmentary, indications of several elements of production also seen at Ašnakkum and Tuttul appear in the administrative and epistolary texts, for example a workshop (*nepāru*) (Sh I 16 and 32), livestock fatteners (Sh II 137), along with the ubiquitous references to fields and agricultural units. The latter is illustrated chiefly through accounts of agricultural produce procured from the threshing floors of surrounding villages, and subsequently transported to the city and entered into the palace storage (Eidem 1992: 28–32). Livestock finds mention in Sh II 137, an inventory list of 138 oxen belonging to Kuwari, and assigned to various tasks, e.g., 30 for plowing and another 25 employed as draft animals. Twenty-one oxen kept for fattening is also listed, with parallels to practices at Ašnakkum. The fragmentary Sh II 126 lists at least 131 sheep entrusted to shepherds. Even if somewhat below numbers seen at Ašnakkum and Tuttul, the scale of these holdings, in terms of agricultural procurements and livestock, are considerable.

A number of texts attest gifts received by Kuwari from officials of Šamšī-Addu, and most likely also from the king himself (Eidem 1992: 22–23). Foremost among these is Kurašānum, the sender of several letters to Kuwari (Sh I 29–33), who also figures in two administrative texts as the donor of gifts for Kuwari and his wife (Sh II 109 and 139). Representatives of Šamšī-Addu were able to draw on supplies from Šušarrā in relation to their activities in the region, as indicated by two sizeable procurements of cereals by the emissary Šumšu-līter (Sh II 43 and 65). Yet this should be juxtaposed with the relatively reciprocal relationship indicated by the bringing of gifts from the Kingdom of Upper Mesopotamia to Kuwari, and the latter's rather headstrong attitude towards the joint dealing with regional political matters in the eastern Tigris drainage observable in the letters (Eidem and Læssøe 2001: 44–55).

What emerges from this admittedly brief survey of textual sources from Šušarrā is a set of converging political infrastructures, namely the relations between a local political and economic entity and the higher echelons of a regional polity. Though it should be kept in mind that the documentation, especially the administrative corpora, is partial and extensively damaged, there is no indication of any lasting interrelation of managerial responsibilities with regards to economic assets between the household of Kuwari and the Kingdom of Upper Mesopotamia. This is hardly a surprising assertion, given the brief time span that elapsed from the establishing of an alliance between Šamšī-Addu and Kuwari to the downfall of the latter. Yet it becomes interesting in light of the evidence from the other two sites considered below.

The Khabūr Plains: AŠnakkum

Tall Šāghir Bāzār, Middle Bronze Age Ašnakkum, is located on the banks of the Wadi Khanzir in the central part of the Khabūr Basin. Excavations at the site overseen by Mallowan from 1935–37 unearthed a relatively small, yet fairly coherent corpus of around 120 administrative texts, of which the large majority was retrieved from a room forming part of a structure that most likely housed the grain storage accountings office (Talon 1997). This group has been substantially enlarged and complemented by recent Syro-Belgian excavations, which have retrieved several hundred contemporary administrative documents from a nearby palatial structure (Tunca and Baghdo 2008). While the former lot offers ample documentation on institutional economic activities, the latter, chiefly comprising records of beer disbursements, is more exclusively concerned with the nuclear palatial household and the comings and goings of messengers and dignitaries.

In the early Middle Bronze Age, the city of Ašnakkum constituted one of the principal urban centres of the Ida-Maraṣ, a region covering the western and central plains of the Khabūr Basin (Guichard 2002: 137–138). Several rulers of Ašnakkum contemporary with Yahdun-Lim, king of Mari in the latter half of the 19th century BCE, find mention in later royal correspondence, often in relation to the important role played by the plains of Ida-Maraṣ as a principal area for the grazing of livestock (Charpin 1990: 68–71). The re-emergence of local elites in the region after the downfall of Šamšī-Addu often saw the conscious invocation of past political structures, as in the following excerpt where a king of Ašnakkum seeks support from a successor of Yahdun-Lim:

> '(…). Forebears of our past, who were in accord (with each other), and whose leaders were joined as one, were powerful. Previously, your forefather supported (the royal claim of) Hadni-Lim. The house of Mari and the house of Ašnakkum is one finger! Since past times, the Ida-maraṣ and the Haneans have been on friendly terms. (…)'[3] FM VI 6 l. 5–12

We find no reference to local lineages at the time when the city came under the control of the Kingdom of Upper Mesopotamia, however. During the decade or so illuminated by texts deriving from the site itself, Ašnakkum was overseen by a resident master named Sîn-iqīšam, assisted by a governor (Akk. šāpiṭu) related to the royal court (Lacambre and Albà 2008a: 211–220). The land of Ida-Maraṣ, though located close to the royal capital of Šamšī-Addu, appears to have been considered under the authority of Yasmah-Addu at Mari, at least during the later years of the kingdom (Villard 2001: 91–94). This is evident especially in the logistical undertakings surrounding a census taken in the year of Adad-bānī (1777 BCE), which saw the visit of Yasmah-Addu and a group of very important royal dignitaries to the city (Talon 1997: 14–17). As may be inferred from the excerpt cited above, Ašnakkum once more became a political player in its own right following the downfall of Šamšī-Addu. Several consecutive — and competing — rulers of the city are attested in the Mari letters and are evidently considered important local authorities, with one marrying a daughter of the king of Mari (Guichard 2002: 140–145).

Overall, the institutional household at Ašnakkum closely agrees with the managerial outline given in ARM XXVI/2 300 cited above, and structures seen also at Šušarrā and Tuttul. The grain disbursement records offer extensive documentation on the scale and organisation of the palace household, Sîn-iqīšam's family, and a sizeable group of servants and their overseers (OBTCB 67, 75, 80, and 86, cf. Talon 1997: 30–31). A larger subset of administrative units is comprised within the workshop ration records, with listings of a range of craftsmen, ox-drivers, and herders (OBTCB 12, 81, 82, 88, 102, 112, 113, and 115, cf. Talon 1997: 25–29). Though there is no explicit reference to agricultural production, a few texts (OBTCB 66 and 70) mention rations for farmers, with additional expansion on agricultural matters offered by accounts of supplementary fodder for 50 plowing oxen (OBTCB 53, 57, and 60). The individual in charge of the plowing oxen at Ašnakkum, a certain Addu-māgir, appears in the workshop ration lists cited above as the supervisor of ox-drivers, suggesting that he was in charge of plow-teams attached to the local administration (Lacambre and Albà 2008b: 226).

More generally, livestock management at Ašnakkum can be analysed from a small, yet very informative set of inspection records (OBTCB 68, 69, 76, and 77) likely dated to the same day in early spring of the year of Awilīya (1779 BCE) (van Koppen 2000: 338). Together, these comprise an inventory of livestock at a location

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[3] FM VI 6: (5) *pa-nu-tum* [*qa-d*]*a-am-ni* ša *bi-ri-*[šu-*nu*] (6) [*ṭ*]*i-iṣ-b*[*u-tu*] ù *qa-qa-da-tu-*[šu-*nu*] (7) [*i*]š-*ti-ni-*[*iš ni*]*-in-mu-da l*[*e-'-ú*] (8) [*pa-n*]*a-nu-um-ma ha-am-ma-*<<NI LI IM>>–[*k*]*a* (9) ^{I}*ha-ad-ni-li-im ik-*(x)-[*d*]*i* (x x) (10) é *ma-ri*^{ki} ù é *aš-na-ak-ki-im*^{ki} (11) ú-*ba-nu-um iš-te*$_{9}$-[*en*] *i-da-ma-ra-aṣ*^{ki} (12) ù ha-*na*-meš *hi-*[*i*]*p-*[šu] *i*[š-t]*u pa-na-ma*

called Til-šannum, presumably a gathering point for cattle herds. As with the example of Sh II 137 from Šušarrā, the texts combine to give the assignment and whereabouts of a total of perhaps 300 to more than 500 heads of cattle of various ages.[4]

In all, this documentation serves to indicate that the management of cattle at Ašnakkum and Til-šannum was clearly a substantial economic enterprise, further accentuated by the official nature of the documents. OBTCB 68 and 69 were underwritten by Apil-Sîn, the governor, and Addu-māgir, the livestock manager, and witnessed by Sîn-iqīšam. The herding of sheep is not explicitly attested at Ašnakkum, but evidence of textile production occupying more than 250 persons (Talon 1997: 17–24) would surely have required a substantial basis for the procurement of wool for weaving.

If these numbers do imply that the institutional household at Ašnakkum represented a substantial economic entity, then relating this entity to regional political networks is, however, less straightforward than usually assumed.

The role of Sîn-iqīšam and his household becomes interesting when juxtaposed with other estates attested in the documentation from Ašnakkum. One such is the House of Šubat-Enlil, which receives regular supplies of cereals from the grain office (OBTCB 73, 78, 79, 91, 93, 96, 103, and 108, cf. Talon 1997: 32–33). Though this estate evidently comprises a household of its own, including servants of various occupations, the available sources do not indicate that the head of the household or any of its personnel took part in the management of the main palace holdings inside or outside of Ašnakkum.

Another estate mentioned in the texts is the House of Ekallātum, located in or close to the city of Ekallātum in the Middle Tigris Valley, seat of Šamšī-Addu's older son Išme-Dagan. This estate appears to be controlled by Sîn-iqīšam, as pointed to by his wife's presence there as inferred from OBTCB 76. Two inspection records (OBTCB 25 and 84) list agricultural workers allocated to this estate, while CB III 179 mentions drovers tasked with driving oxen and sheep to Ekallātum.

It seems generally accepted that Sîn-iqīšam represents the principal resident authority at Ašnakkum within the timespan covered by the administrative documentation, jointly inferred from his prominent position in the palace ration records and his affirmative role in the cattle inspections. A cylinder seal of unknown provenance currently in the Louvre, is attributed to Sîn-iqīšam by Lacambre and Alba (Lacambre and Albà 2008a: 214–215) though this attribution rests solely on the corresponding name.[5] Other external evidence as to his position is limited to a letter sent to Mari, jointly authored by Sîn-iqīšam and a scribe from the court of Šamšī-Addu at Šubat-Enlil, and apparently related to the performance of a ritual connected to celestial cycles (FM VIII 41; see also Lacambre and Albà 2008c: 296–297).

In institutional terms, one is inclined to consider Ašnakkum administratively subordinated to one of the main seats of the state, namely Šubat-Enlil or Mari and controlled by a centrally appointed governor, as is the case at Tuttul, more on which below. Yet Apil-Sîn, who can be securely associated with this office, appears marginal to institutional responsibilities at Ašnakkum. Furthermore, the presence of an estate at Ašnakkum clearly associated with the royal court at Šubat-Enlil makes little sense if the city's administration did indeed form an integrated element of the state apparatus. This is not to suggest a relative equation of independent political entities, merely to stipulate the seeming presence of multiple points of political authority in the textual evidence from Ašnakkum itself. As demonstrated by the substantial issues of resources from the city's storages during the census taking mentioned above (Talon 1997: 15–17 for an overview of this dossier), the kingdom was clearly able to draw on local infrastructure, a situation paralleled at Šušarrā. Yet all instances of interaction between state representatives and the local household appear to be of a temporal nature, save of course for the estate of Šubat-Enlil. This situation stands in contrast to the palatial administration at Tuttul, to which we may now turn.

The Balikh: Tuttul

Tall Bī'a, Bronze Age Tuttul, is located at the confluence of the Euphrates and Balikh rivers in the upper part of the Middle Euphrates Valley. As an important cultic centre dedicated to the god Dagan, Tuttul constituted a principal locus of political and religious power in the Middle Euphrates region (Feliu 2003: 118–125). This is further accentuated by its strategic geographical position at the intersection of several important infrastructural corridors linking the Balikh Valley and the plains below the Taurus range with the Middle Euphrates Valley and the steppe of inner Syria.

This all serves to explain the prominence allocated to Tuttul in sources from Mari. Yahdun-Lim, ruler of Mari at the turn of the 19th century BCE commemorated a campaign against a king of the city, and subsequently

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[4] When adding to the numbers from the inspection records OBTCB 23, an issue of winter fodder for a herd of 216 bulls and calves.

[5] RIMA 1 A.0.39.2019 (1) ^{d}en-zu-*i-qí-ša-am* (2) dumu *bur-*^{d}i[m] (3) ìr ^{d}utu-ši-^{d}im. On the same grounds, the seal in question is equally attributable to a musician from the Diyala region named Sîn-iqīšam, subject of two recently edited letters, who was clearly held in high regard by Šamšī-Addu (cf. Ziegler 2007: 289).

boasted his power as 'king of Mari, Tuttul, and the land of Hanâ'.[6] The geo-political association of Tuttul and Mari was maintained throughout the remainder of the Middle Bronze Age. During the reign of Šamšī-Addu, the city was overseen by a resident governor (*šāpiṭu*) answerable to the king's son, Yasmah-Addu, who appears to have presided over the same environs as the former kings of the city. Zimri-Lim, asserting himself as the rightful heir of Yahdun-Lim's dynasty after the fall of Šamšī-Addu, reclaimed the title as 'king of Mari, Tuttul, and the land of Hanâ'.[7] Thus, it seems that the politico-ideological realm of Yahdun-Lim was maintained, albeit by different rulers, for the better part of a century. Apparently, the last known governor of Tuttul during the reign of Yasmah-Addu, a certain Habduma-Dagan, maintained his position as governor after the demise of his king, and was eventually transferred to a similar position elsewhere in the kingdom of Zimri-Lim (Villard 2001: 90).

Administrative sources from Tuttul derive from excavations of the Middle Bronze Age palace and comprise some 200 texts associated with the reign of Šamšī-Addu (Krebernik 2001). Discovered in various secondary deposits, it is naturally a matter of some speculation to assign these texts to one or more distinct administrative units. The many parallels with administrative structures at Ašnakkum should be considered in support of the analysis given below. Providing an outline of the institutional administration at Tuttul is further facilitated by epistolary sources from Mari.

As with the palatial household of Sîn-iqīšam at Ašnakkum, the economic organisation of the palace at Tuttul shows many parallels with the outline provided by ARM XXVI/2 300. Agricultural production is well attested, and encompassed both the riverbanks around the city, while also reaching well into the Balikh Valley, including the management of fields around the town of Ṣerda a day's journey to the north.

The spatial extent of these undertakings can be reconstructed from KTT 120, an account of agricultural produce delivered to the palatial grain storage at Tuttul in the early autumn of the year of Adad-bāni (1777 BCE). KTT 120 orders grain received by the farmer responsible and the threshing floor from which it derives, a practice partially similar to managerial structures seen at Šušarrā. Agricultural workers overseen by these farmers are the subject of KTT 137 and 166, which, though both partially damaged, list rations for men, women, and oxen on a monthly basis. From KTT 120, we learn that grain procured from threshing floors around Tuttul and from Ṣerda to the north amounted to a grand total of 1384275 *qû* (equal to circa 1080 ton of barley[8]). Though the entire lot was apparently delivered to Tuttul, it should be noted that surrounding settlements could also hold extensive amounts of grain. The fragmentary KTT 116, dating to the first months of Adad-bāni, lists 62696.5 *qû* (or close to 49 ton of barley) from the grain heap (*karû*) at Ṣerda.

The scale of livestock management in the Balikh Valley can be analysed through a substantial corpus of clay tags (KTT 183–266). Each denoting a dead cow, such tags were issued in order to clear the herder responsible of claims relating to lost property upon returning the herd to the owner (Postgate 1975: 6–7). Similar examples are known from the reign of Yahdun-Lim at Mari (Charpin 1994: 178). As the tags state the age of the cow, the name of the herdsman responsible, and the name of their supervising authority, they offer valuable information both on the structure of grazing practices and the incorporation of such practices into the overall management of institutional households. In the present case, the clay tags are all concerned with cattle pertaining to state authorities resident at Šubat-Šamaš, a settlement located somewhere in the central reaches of the Balikh drainage (Charpin and Durand 1986: 183).

The presence of these records at Tuttul betrays an administrative link between these two sites and the royal court at Mari, as the individuals mentioned in the clay tags are all associated with the state administration. This point can be further augmented through epistolary sources from Mari, where a letter alludes to 1200 heads of cattle managed by state officials at Šubat-Šamaš (ARM I 118). Though the number may seem a case of diplomatic hyperbole, it receives indirect support from the Tuttul clay tags, if one considers the latter assemblage to denote a (minimum) mortality rate for the number of cattle given in this letter[9].

Economic activities at Tuttul and further north in the Balikh figure prominently in the Mari sources. The supply of water for irrigation around Ṣerda forms the subject of a heated series of letters relating to Yasmah-Addu and administrators in Šubat-Šamaš (Villard 1987). In ARM I 118, Yasmah-Addu writes his father concerning the mismanagement of the aforementioned 1200 heads of cattle at the hands of a negligent head

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[6] Consider royal inscriptions RIME 4 4.6.8.2 l. 70–71 and 4.6.8.1 l. 3–5 respectively.

[7] RIME 4 4.6.12.3 l. 1–4.

[8] Assuming the absolute measure of the *qû* employed here to be 1.2 litres (cf. Krebernik 2001: 164–165), subsequently multiplied by a barley bulk density of 0.65 l/kg.

[9] According to this dossier of tags, the total number of heads reported dead by the herders in the year of Rigmānum (1784 BCE) is 49, and 12 in the year of Ikūn-pīya (1783 BCE) (Krebernik 2001: 111–116), which equals respectively 4% and 1% of 1200. These numbers are only slightly below general mortality rates for pasturing cattle in developing countries (cf. Dahl and Hjort 1976: 37–39).

of the administration at Šubat-Šamaš. Sîn-tiri, a very high-ranking authority of the kingdom and apparently overseeing affairs at Šubat-Šamaš, subsequently allocates workers to tend cattle in the district of Tuttul (Villard 2001: 86).

Tuttul represents one of the more extensively documented governorates of the Kingdom of Upper Mesopotamia. Three named governors are attested during the reign of Yasmah-Addu at Mari (Villard 2001: 87–90). Though it may be convenient to connect the authority of governor to a defined territory, both conflicting and functional relationships between various local authorities of the state indicate that things were certainly more blurred, as hinted at in the disputes between Tuttul, Šubat-Šamaš, and Mari administrators (Fleming 2004: 135–138; Villard 2001: 115–116).

Even so, it is clear that managing entities at Tuttul constituted an integrated part of state affairs in contrast to the two cases of Ašnakkum and Šušarrā considered earlier. Several individuals subordinate to the governor and charged with overseeing various aspects of agricultural and household affairs are attested in internal as well as external sources. While acting in relation to everyday matters of economic management, they were clearly intimately related to officials of the royal courts.

The best example is a certain Sîn-riṣušu, overseer of substantial parts of the grain received in KTT 120 mentioned above. While appearing in several administrative documents from Tuttul courtesy of his association with the management of the palace grain storages (e.g. KTT 111, 118, 119, 120, 134, 165, and 321), he is also mentioned in a Mari letter as charged with the supervision of an estate next to his duties as palace attendant at Tuttul (Villard 2001: 91 n. 552).

Several more cases could be presented in parallel, but even without going to such lengths, it appears safe to assert that the administrative outline derived from the texts found at Tuttul amply demonstrates a close association of the local institutional household and the uppermost echelons of the Kingdom of Upper Mesopotamia. This is evident not only in the case of resident administrators, like the governor or lower-ranking officials such as Sîn-riṣušu, but also in the extent of the wider managerial infrastructure that relates the institutional household at Tuttul to entities at Mari and Šubat-Šamaš.

Discussion: economic organisation and political networks

Select assemblages of texts on economic matters from the three sites considered here demonstrate that impact and durability of regional political entities could take on very different forms according to local circumstance. Yet this appears less to do with the materiality, organisation, and scale of local economies than with the resilience of local political tradition and practice.

Perceiving of Šušarrā within a reciprocal framework of symbolic and political affirmation is hardly controversial, given the brevity of relations between local political structures and the Kingdom of Upper Mesopotamia. Nor should the localised nature of economic management surprise us in this perspective.

In contrast, textual sources from Ašnakkum demonstrate a blurred demarcation of political entities. Despite the relative coherency of the administrative record unearthed, and the ability of this record to elucidate social relationships both internal and external to the principal institutional household found there, a clear organisational hierarchy traversing the interface between local and regional powers-that-be is lacking.

Overall, the published assemblage of texts currently available from the site offers suspiciously minute, if any, indication of lasting administrative relationships between Ašnakkum and the royal cities of Šamšī-Addu and his sons. Naturally, we are all subject to the future finding of evidence to the contrary, yet the textual sample from Tuttul discussed here is of a far more partial nature, in terms of documentary consistency and state of preservation, than its counterpart at Ašnakkum. Still, the former is capable of demonstrating an economic structure closely linked to regional political networks, as opposed to the latter.

Tuttul, to attend to the case most proximal to what we could consider an example of extended territorial control, forms an integrated part of state affairs, in a political *and* economic sense. Not only are economic assets clearly a cause for attention in the political correspondence, local individuals subservient to the rulers of the Kingdom of Upper Mesopotamia are also charged with overseeing their acquisition, management, and use.

The spatial differentiation of political and economic control elucidated by the analysis of textual sources given here lends important correlates to archaeological approaches to the structuring power of political institutions in the shaping of the social landscape. Notwithstanding recent theoretical developments, spatial perceptions of early states in Ancient Near Eastern research tend to be bound within an ontological framework that conceives of territory as a static backdrop to expressions of political and ideological sovereignty, be it the pompous imagery of royal narrative and monumental symbolism, the tracing of campaigning armies, or the attentive eye of governance permeating the letters of kings and their dignitaries.

Yet the economic substratum provides for very different perspectives suggestive of a relational configuration of social spaces, in which regional political power is manifested by various degrees of political and economic impact and permeability at a local level. Material expressions of economic organisation may, in other words, as much be the result of more subtle and durable traditions of local social structure as the conscious work of emergent regional political entities. Acknowledging infrastructural constraints on the scale and social impact of Bronze Age political economies, as seen in a number of recent studies (Paulette 2015; Rattenborg 2016) will no doubt add further depth to future research on the interplay between nascent territorial states and the material foundations of early complex societies.

Concurrent with the increasing level of temporal and spatial resolution obtained in archaeological research on the Ancient Near Eastern landscape, the present study then stresses the need to incorporate more fully textual evidence into analyses of political and economic structure and settlement organisation, and to situate such analyses within a conceptual framework sensitive towards the interplay of multiple social agents, spaces, networks, and institutions.

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Resurrecting Tello (Ancient Girsu): The Topographical Layout of an Early Dynastic Sumerian City

Sébastien Rey and Camille Lecompte[1]

Girsu (present day Tello) and the sumerian miracle[1]

Tello was the first Sumerian-like site to be extensively excavated between 1877 and 1933 by four French expeditions successively led by the vice-consul at Basra in present-day Iraq, E. de Sarzec, in collaboration with L. Heuzey and the Louvre Museum (1877–1900); the commander-ranked officer G. Cros from 1903 to 1909; the abbot H. de Genouillac in 1929–1931; and A. Parrot from 1931 to 1933 (Cros 1910; Genouillac 1934–36; Heuzey 1900; Parrot 1948; Sarzec and Heuzey 1884–1912). The pioneering explorations carried out by these first Orientalist researchers and the early decipherment of Girsu cuneiform tablets by the epigrapher F. Thureau-Dangin, one of the founders of Assyriology, indeed revealed the principal catalytic elements of the Sumerian miracle — that is, a multiplicity and coalescence of major innovations, such as the appearance of the state, of a city-countryside integrated economy, the development of literacy, of bronze manufacture, and the emergence of monumental art and architecture (Rey 2015 : 55–62).

The 20 field campaigns led in fact to the identification of a palimpsest of five main periods of occupation, including the protohistoric times (Ubaid, Uruk, and Jemdet Nasr), the Early Dynastic Period (roughly corresponding to the time of the First dynasty of Lagaš), the Akkadian–Ur III Periods (including the Second dynasty of Lagaš), the Isin-Larsa–Old Babylonian times, and the Aramaic Period (palace of Adad-nadin-aḫḫe). Remains of the Early Dynastic Period have been uncovered principally in the central part of the site, that is, at the Tell K, also referred to since E. de Sarzec and L. Heuzey as the mound of the *Maison des fruits*, the sole stratigraphic-like sequence of Lagaš I temple structures, the Tell I (Tell I'), the Tell P (Tell P'), so-called *Porte du Diable* after G. Cros, and probably at the eastern tells under H. de Genouillac and A. Parrot. Most of the pre-Sargonic cuneiform tablets, circa 1800 economic tablets and fragments from the queen's agro-managerial household, successively called e$_2$-mi$_2$, the 'wife's house' and e$_2$-^{d}Ba-U$_2$, the temple of the goddess Ba-U$_2$ (diversely interpreted as Ba'u, Baba, Bawu, etc., here merely transliterated as Ba-U$_2$), the divine counterpart to the ruler's wife, were unearthed during non-regular excavations and lootings. By contrast, most of the royal inscriptions have been partly discovered in the Eninnu temple of Girsu and the Bagara temple of Lagaš (modern al-Hiba). Because of the incomparable richness of information related in particular to the city's spatial organisation, Girsu clearly stands out as a primary locus for analysing the urban landscape of a Sumerian religious power in the Early Dynastic Period.

Moving landscape and the power of space imagery

Today, the site is a complex of mounds rising some 15 metres above the flat alluvial surrounding lands situated on exposed surfaces of a Holocene oval-shaped 'turtleback' measuring circa 3000 metres in length (i.e., from north to south), and 2000 metres in width (i.e., from east to west). Only two comprehensive topographic maps were probably made of the latter, including the archaeological mounds: the first accurate plan of the site, including one metre interval contour lines, was carried out between 1877 and 1900 by H. de Sevelinges, the topographer of E. de Sarzec (Sarzec and Heuzey 1884–1912: plan B); the second map, yet not correctly oriented — that is, roughly facing northeast — of the whole complex, including the approximately situated excavated areas of previous campaigns, was completed in 1929–31 under the direction of H. de Genouillac (Genouillac 1934–36: pl. xiv). Also, the 1934 publication of the latter features a Royal Air Force undated, unscaled, and not geo-rectified aerial photography of the site. Although the plan published in 1948 by A. Parrot is properly oriented (that is, facing north), comprises an increased number of contour lines, and includes the entire field operations conducted since E. de Sarzec, a doubt yet arises about the fact that the site was resurveyed between 1931 and 1933 by means of levelling-type instruments: the plan appears to have been merely redrawn from the previous one (cf. Parrot 1948: 29). As for the topographic-like map made by G. Cros in 1903–09 of the large-scale tells of the site, it displays very rough contour lines that do not correspond to the general topography, and major scale errors, including flagrant mis-locations of exposed

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[1] In memory of Professor Tony Wilkinson. Girsu's pre-Sargonic spatial organisation has been reconstructed from an interdisciplinary approach. I am grateful to the Fragile Crescent Project research team of Durham University for having made available the satellite imagery and associated analytical technology.

New Agendas in Remote Sensing and Landscape Archaeology in the Near East (Archaeopress 2020): 213–227

Figure 15.1. Superimposed 1968 CORONA space photography of Tello/Girsu (1), geographically corrected plan of 1877–1900 (2), and ortho-rectified RAF aerial imagery (3).

architectural structures, and therefore it seems more likely to have been sketched rather than completed using automatic levels (cf. Cros 1910: plan K).

If the graphic information of Tello in its entirety remains problematic, including of course the detailed plans of Early Dynastic architectonic features (and this fact has recently lead Mesopotamian scholars to alter, somewhat arbitrarily, these plans, or even to completely relocate entire field operations, solely on the grounds that pre-Sargonic structures have been so inadequately recorded (cf. Marchesi and Marchetti 2011: 38–44; Margueron 2005: 63–92)) then the recent availability of United States declassified space photography offer new and valuable material for archaeological and epigraphic studies of the city's ancient landscape and hinterland (Pournelle 2007: 29–62). Code-named CORONA satellite images taken for the Central Intelligence Agency from 1959 to 1972 have indeed proven to be an important resource not only for the identification of archeological sites on a regional scale but also of previously non-documented tenuous relict surface features (Philip *et al.* 2002: 109–118; Pournelle 2007: 29–62; Wilkinson 2003). Geo-referenced (i.e., transformed into a geographic co-ordinate system), these images, moreover, permit, from photographic interpretation of specific recurrent landmarks, to ortho-rectify the British air services' imagery and to quasi-geographically correct the topographic maps, that is, to re-project them to a common scale and orientation. One of this paper's primary aims, therefore, is to reconstruct, through the analysis of these relatively high-resolution photographs by means of remote-sensing techniques in light of evidence from previous archeological and epigraphic studies, a new topographic plan of pre-Sargonic Girsu.

The spatial morphogenesis of a sumerian megapolis

The geo-corrected American CORONA imagery displaying the 1968 topographical layout of Tello enables first to measure accurately its surface — that is, circa 130 hectares — an area which is considerably reduced compared to the extremely varying estimates given previously by the French archaeologists who described the site rather impressionistically as having substantially the shape of an ellipse measuring in length

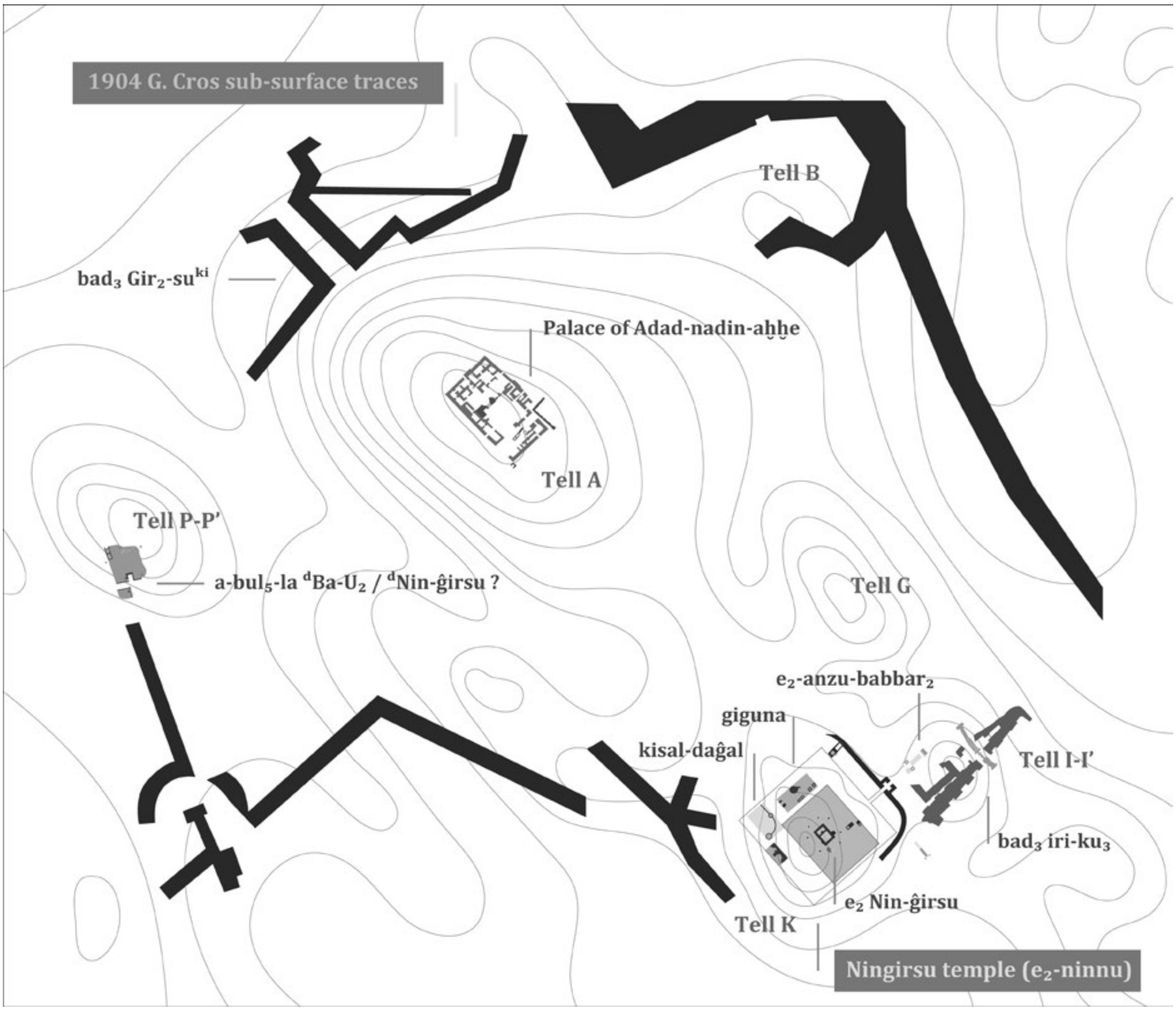

Figure 15.2. Spatial organisation of the sacred precinct area/acropolis (Iri-ku$_3$) of Girsu featuring the principal exposed architectural ruins including the temple of Ningirsu (E$_2$-ninnu), and the 1904 sub-surface network of fortifications.

between 3000 and 4000 metres, and in width between 1500 and 3000 metres (cf. Cros 1910: 5; Genouillac 1936: 2; Parrot 1948: 9).[2] Of course, the significant difference in assessment of the site's size is largely due to confusion between the proper boundaries of the complex of archeological mounds and the fluctuating delimitations of the elevated 'turtleback' (i.e., Holocene knoll-type geomorphologic feature) upon which the former rests. Also, this could probably account for the fact that the perimeters indicated on Sarzec's plan coincide neither with those of respectively the de Genouillac and Parrot maps and sketches, nor with those that are perceptible both on the RAF and CORONA photographs. If the surface of the 'turtleback' constantly evolved from 1877 to 1968 (and to the present day), the analysis of the post-World War I aerial photography and the 1968 space imagery reveals evidence of archaic fortification features of probable Early Dynastic date (cf. below) that encompass roughly one-third of its land area (cf. Pournelle 2003: 179).

Even though most of the data produced since de Sarzec and Heuzey should be subject to caution, the early descriptions of the site's topography by these pioneering Orientalists, as much as the first plan made by de Sevelinges and the schematic plan of Cros, have proven to be tremendously valuable since massive amounts of the 1877–1909 excavation spoil completely conceal, at least for the central tells of the site, any

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[2] The size of circa 130 hectares corresponding to the circumvallated space and the so-called western mounds (cf. below) in fact excludes any hypothetical peripheral and suburban areas that may have existed in the Early Dynastic Period. According to the pre-Sargonic administrative documents Girsu's near periphery included a nonurban settlement, probably a large village designed as e2-za3-iri-ka, that is, the 'House (i.e., a village) on the border of the city (of Girsu),' consisting of important rural storage structures nearby the city (or adjacent to Tello) where e.g., quantity of timber material and reeds were stored. The CORONA space imagery principally used in the present article was taken May 4, 1968 (DS 1103–1041DA057).

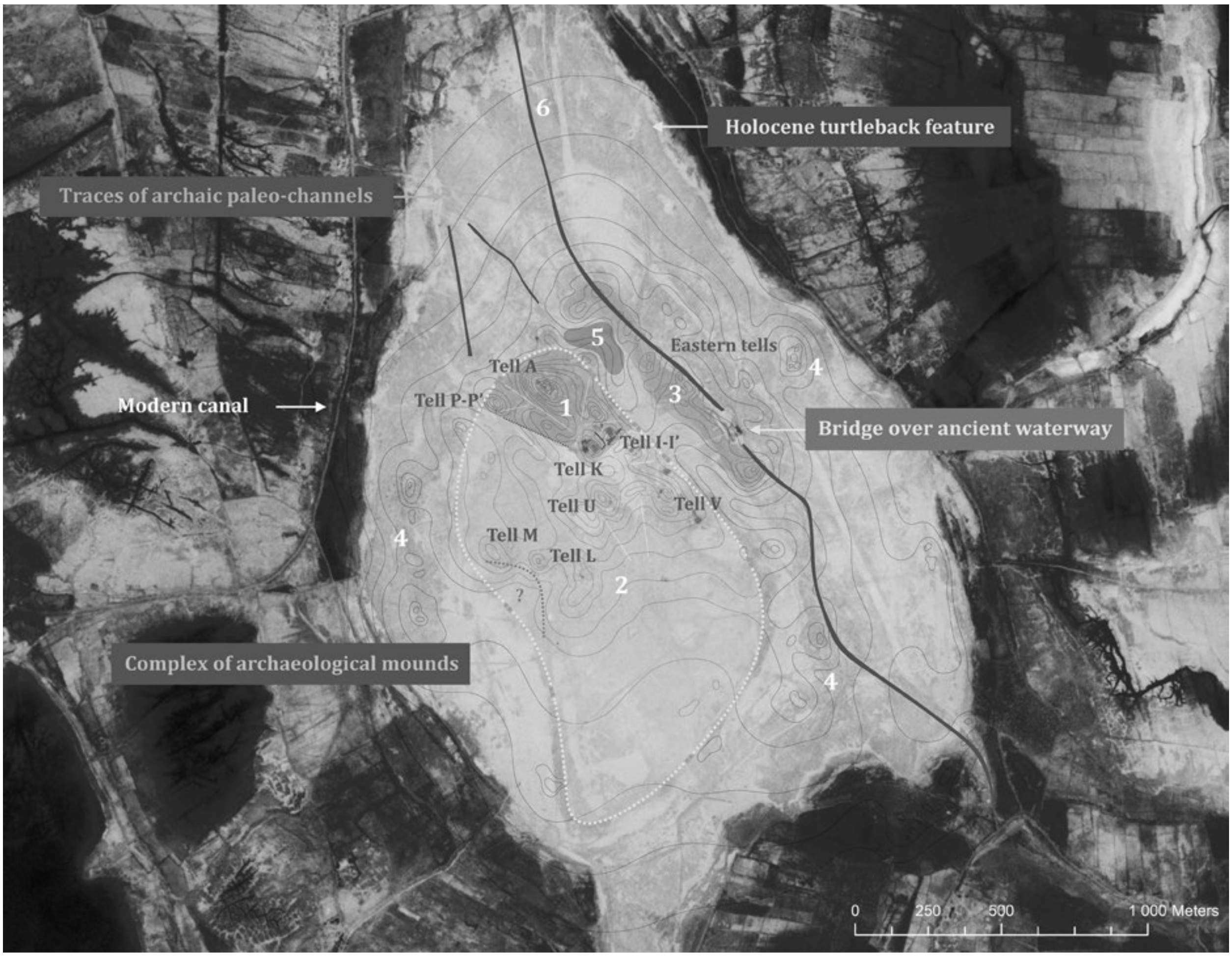

Figure 15.3. Principal topographical features and quarters of Tello/Girsu revealed by the 1968 CORONA satellite imagery, including the sacred city Iri-ku$_3$ (1), the central and southern areas (2), the eastern extramural district (3), the peripheral tells and suburban areas (4), the probable city harbour kar-ma$_2$-addir$_x$ (5), and the mega-canal i$_7$-Niğin$_6^{ki}$-DU-a (6).

significant landscape features that could have been noticeable either on the RAF imagery or the 1968 CORONA photography. Thus, prior to the first large-scale French excavations in the late 19th-century Ottoman-era Iraq, the site would have appeared as a multi-mounded complex, including two main and unequal precincts of respectively circa 115 and 15 hectares separated by two major wadi-like gullies (i.e., thalwegs) running from northwest to southeast, in opposite directions, from a central pass-like feature that clearly stood out in the topography. Both areas comprised many mounds of varying sizes and morphologic types: the spatial organisation of the larger district consisted of a northern part of circa 35 hectares including four first-tier tells ranging from circa 12 to 14 metres above the surrounding Holocene plains (i.e., from north to south: Tell A, Tell K, Tell U, and Tell V), and a relatively flat and homogenous southern part of circa 80 hectares. The general layout of the eastern district consisted of a series of second- or third-tier tells ranging from circa 7 to 9 metres in altitude, and in alignment from northwest to southeast.

Excavations from 1877 to 1933 have produced only unequivocal monumental and elite related data for the pre-Sargonic Period, and therefore no substantial information is available on the non-elite and secular domestic-like sectors of the urban layout (cf. Parrot 1948: 54–132). Also, subjected to systematic surface analysis as early as 1904, the site yielded plausible Early Dynastic sub-surface traces of fortification and hydraulic features, including the quasi-complete network of complex mudbrick enceintes featuring firing platforms and defended gates circumvallating part of the main political-cultic hub of the city (i.e., part of the northern district encompassing Tell A, Tell K, and Tell I–I'), and the city harbour and associated canals (i.e., situated nearby the Tell B) (cf. Cros 1910: 64). Superimposed RAF and CORONA imagery made it possible to confirm the identification of some of these linear soil marks that are characteristic either of archaic enceintes or palaeo-canals and appear therefore both on the ground and aerial satellite photography (contra Genouillac 1936: 3, and Parrot 1948: 148, who have, therefore, erroneously contradicted the preliminary interpretations of Cros).

Careful re-examination of these evanescent and fairly controversial landscape marks that have been mapped by means of remote sensing methods and with reference to the archaeological and epigraphic evidence, thus, led to a reappraisal of the general layout of pre-Sargonic Girsu.

Multivallation for the purpose of coercion and defense

Overall, no less than two connecting fortification systems have been reconstructed from a multidisciplinary approach: the inner perimeter of circa 1500 metres already identified by Cros and enclosing a sacred precinct of certainly large-scale cultic architecture (cf. below), and a second outer defense perhaps fronted by ditches of circa 3500 metres detectable both on the RAF and CORONA images and probably surrounding a proper urban-type space of combined preplanned political-religious hubs (i.e., Tell V, Tell U, and Tell L) and hypothetical plebeian and secular densely built-up domestic areas (i.e., the most part of the southern flat area of the site). Evidently, if the newly identified exterior fortifications are extremely difficult or impossible to date until renewed wide-scale ground exploration becomes possible, a few uncovered stretches of the inner curtain made of plano-convex mudbricks and pierced by a defended gate (Tell P-P') have ascertained that at least part of the interior fortifications dates to the Early Dynastic Period (cf. Cros1910: 265–276). In fact, apart from some cuneiform sources, the sole archaeological evidence pertaining to a chronological synchronism between both defensive systems appears to be a stretch of archaic mudbrick enceinte reinforced by a bastion-like feature exposed by de Genouillac along the site's outer perimeter (Tell L), but unfortunately no other information or even a plan of these structures is available (cf. Genouillac 1936: 3).

Excavations in the mound referred to since Cros's excavations as the *Porte du Diable* (Tell P-P') — apparently for its apotropaic character according to an Arab local legend — and situated in the northwesternmost part of the northern multi-mounded area of the site, revealed the remains of a pre-Sargonic complex-type chambered gate consisting of a straight circa 3 metre-wide entrance consisting of two sets of buttress-like structures en vis-à-vis and flanked by several portions of enceinte, which include casemate-like features and measure circa 12 metres in width (cf. Cros 1910: 265–276). In fact, at least two main phases have been posited for the four-pier gate and inner defenses: the first phase probably dating to the reign of Ur-Nanše on the basis of mudbrick dimensions; the second phase perhaps corresponding to the reign of E-anatum on the basis of structural features (Cros 1910: 266). Although the later Lagaš II circa 10 metre-wide rampart constructed during the reign of Gudea from perfectly square-shaped mudbricks and featuring notably interior and exterior salient buttress-like structures and terracotta inscribed cones had been unearthed by Cros in another part of the main temple precinct (Tell I-I'), it likely enclosed the same earlier Lagaš I sacred area and therefore might have been erected directly on the remains of alleged fortification features (cf. Cros 1910: 305–308; Genouillac 1936: 2–3; Parrot 1948: 148).

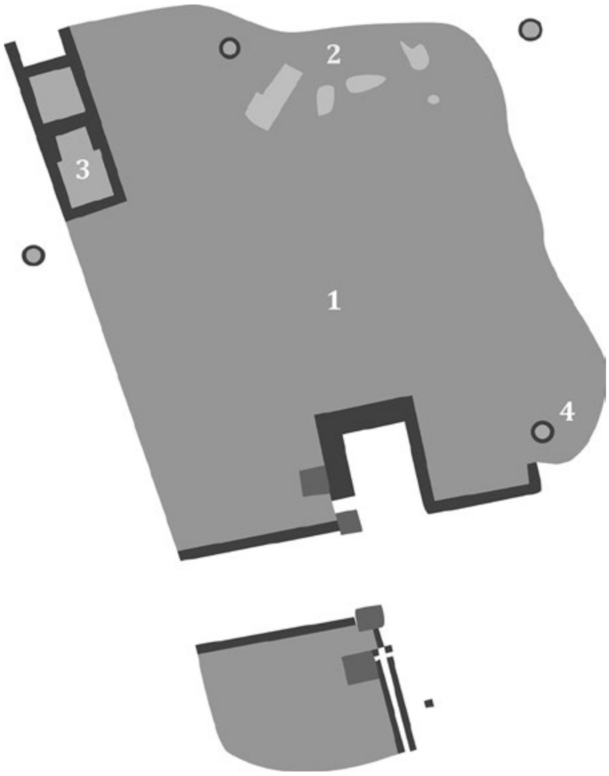

Figure 15.4. Plan of the Early Dynastic defended gate of the mound of the *Porte du Diable* (Tell P-P'), either a-bul$_5$-la-^{d}Ba-U$_2$ or -bul$_5$-la-^{d}Nin-ĝir$_2$-su, featuring (1) the mudbrick enceinte (Ur-Nanše/E-anatum); (2) collapsed adobe structures (Iri-KA-gina); (3) the vaulted construction; (4) drainage installations to evacuate rainwater.

Also, the particular multivallated configuration — that is, multiple enclosures circumvallating spaces defined by their layouts and functions that differ considerably with one another — may be reflected in the Early Dynastic III textual records. But if the iri-ku$_3$ designating the 'holy quarter' of the city in all likelihood corresponds physically to the major part of the northern district including in particular the first-tier mounds of the *Maison des fruits* (Tell K) and of the *Palais* (Tell A), it also encompasses in its broadest sense (i.e., probably economically and symbolically after Selz (1995: 122, 238)) rural chapels and shrines in the countryside (e.g., the frontier sanctuaries of

An-ta-sur-ra and Ti-ra-aš$_2$ nearby the disputed border of Umma city state). That the iri-ku$_3$ differs from the e$_2$-ninnu — that is, the temple precinct of Ningirsu (cf. below) — appears rather self-explanatory, although the relationship between both is rather ambiguous. Yet according to A. Falkenstein (1966: 121), it clearly includes the latter to form a broader religious compound, containing also the temple of Ḫendur-sag̃ (i.e., the e$_2$-gal-iri-ku$_3$) constructed by En-anatum I (cf. Frayne 2008: 171, E1.9.4.2: 182, E1.9.4.10; see Selz 1995: 143), other cultic edifices and storage facilities, such as the e$_2$-ezen-da-iri-ku$_3$, and the e$_2$-u$_4$-sakar-iri-ku$_3$,[3] and, of course, the temple of Ba-U$_2$ (i.e., the e$_2$-TAR-sir$_2$-sir$_2$), constructed by Ur-Nanše (see below) (cf. Frayne 2008: 114, E1.9.1.29; see Selz 1995: 26).

Administrative tablets from the time of Iri-KA-gina's reign (diversely considered to be Urukagina, Iri'inimgina, etc.), which refer to offerings and sacrifices performed during a possible procession by the queen Sa$_6$-sa$_6$ in the iri-ku$_3$ precinct on the first and last day of the Ningirsu's festival, may also point to a multi-tiered organisation of the latter (cf. Rosengarten 1960: 281; Selz 1995: 236–238; see Lecompte forthcoming). And though philological problems may hamper the understanding of the royal inscriptions and the administrative documents of the First Dynasty of Lagaš — e.g., the identification of many terms is subject to caution and translations to some extant based upon arduous etymological interpretations have been a matter of scholarly debate — several of the official and archival documents suggest that pre-Sargonic Girsu was enclosed by at least two fortification walls: the bad$_3$ iri-ku$_3$, the 'enceinte of the holy precinct' and the bad$_3$ G̃ir$_2$-su^{ki}, the 'enceinte of the city of Girsu'.

E-anatum's royal inscriptions found on boundary stones and boulders commemorating battles and campaigns directed against Elam, Umma, Uruk, Ur, and other foes, mention that 'He (E-anatum) built the wall of the holy precinct for him (Nin-^{d}g̃ir$_2$-su)' (cf. Frayne 2008: 147, E1.9.3.5, iii. 7-8: bad$_3$ iri-ku$_3$-ka / mu-na-du$_3$, E1.9.3.6, iii, 3–7). Several other administrative documents of the reign of Iri-KA-gina also refer but implicitly to this interior enceinte, dealing precisely with the restoration of the bad$_3$ e$_2$-^{d}Ba-U$_2$ — probably identical with the bad$_3$ iri-ku$_3$ on the basis of a later Gudea royal inscription stating that 'For Ba-U$_2$, the beautiful woman, daughter of An, the lady of the iri-ku$_3$, his lady, Gudea, ruler of Lagaš who had (already) built the e$_2$-ninnu of Ningirsu, built her wall of the iri-ku$_3$' (cf. Edzard 1997: 111, E3.1.1.7.5). As for the bad$_3$ G̃ir$_2$-su^{ki}, it is only attested in corpora of Iri-KA-gina's reign, either in royal inscriptions found on clay cones, including a recension of the so-called Reform texts (that is, the reforms carried out by the probable usurper to correct abuses that apparently had been perpetrated by earlier rulers of Lagaš), 'He (Iri-KA-gina) built the wall of Girsu for him (Nin-g̃irsu)' (cf. Frayne 2008: 259, E1.9.9.1, ii, 14 – iii, 1: bad$_3$ G̃ir$_2$-su^{ki} / mu-na-du$_3$), on another clay cone stating that 'He encircled Girsu (with a wall) … He made its wall grow up' (cf. Frayne 2008: 276, E1.9.9.4, iii', 6'–7': bad$_3$-bi / i$_3$-ni-mu$_{2)}$, or on a brick fragment recording the probable restoration or construction of this enceinte (cf. Frayne 2008: 284, E1. 9.9.10).

That the bad$_3$ iri-ku$_3$ and the bad$_3$ G̃ir$_2$-su^{ki} are not one and the same fortification structure (i.e., interchangeable terms) is proven by the fact that both are seemingly attested in contemporaneous epigraphic records of Iri-KA-gina's reign, but whether the latter also denotes the entire circumvallated urban space, therefore including the sacred quarter, is a subject of controversy. Patently, the ambiguity arises from the fact that the lines of walling reconstructed from the aerial satellite imagery and the archeological evidence are contiguous, and in consequence, the portion of plano-convex mudbrick curtain uncovered in the mound of the *Porte du Diable* at the edge of the site (Tell P-P') — also the supposed periphery of the iri-ku$_3$ — is de facto part of the 'enceinte of the holy precinct' as well as that of the 'enceinte of the city of Girsu' on the basis of the above-mentioned inscribed clay cone unearthed in the vicinity.[4] Yet it is clear that the stretch of square-shaped mudbrick curtain, already mentioned, uncovered in the environment of the mound of the *Maison des fruits* at the centre of the site (Tell I-I') — even if it dates to the Second Dynasty of Lagaš — may only designate the bad$_3$ iri-ku$_3$ since it yielded numerous terracotta cones of Gudea and because of its particular topographic situation (cf. Cros 1910: 305; Parrot 1948: 148; about the identification of the inscriptions found by Cros but seemingly never published, cf. Lecompte 2014: 2).

A thorough morphologic study of the complex of Tello enhanced by analysis of the RAF and CORONA imagery led to the identification of several possible defended gates, in addition to the one exposed in the mound of the *Porte du Diable* (Tell P-P'), which overlap the bad$_3$ iri-ku$_3$ and the bad$_3$ G̃ir$_2$-su^{ki} and are characterised by wide-scale breaks in these otherwise continuous polygonal-type inner and outer defenses. They are frequently situated at the end of the major more or less radial wadi-like ravines of the site and set nearby abutting mounds: at least five have been posited for the sacred precinct (i.e., part of the northern area), and certainly as many, perhaps even more, for the combined elite-

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[3] Both e$_2$-ezen-da-iri-ku$_3$ and e$_2$-u$_4$-sakar-iri-ku$_3$ are only attested in administrative records: cf. Selz 1995: 69–70 about the former; the latter is mentioned in three texts: Nik 1, 149, DP 44, and DP 200.

[4] Cf. Cros 1910: 64. Contra Frayne 2008: 275, who has interpreted the inscription to be connected with the construction of the (temenos) wall at Girsu; the enceinte of the latter clearly corresponds to a large-scale fortification feature, not a barrier-type symbolic structure surrounding a religious precinct.

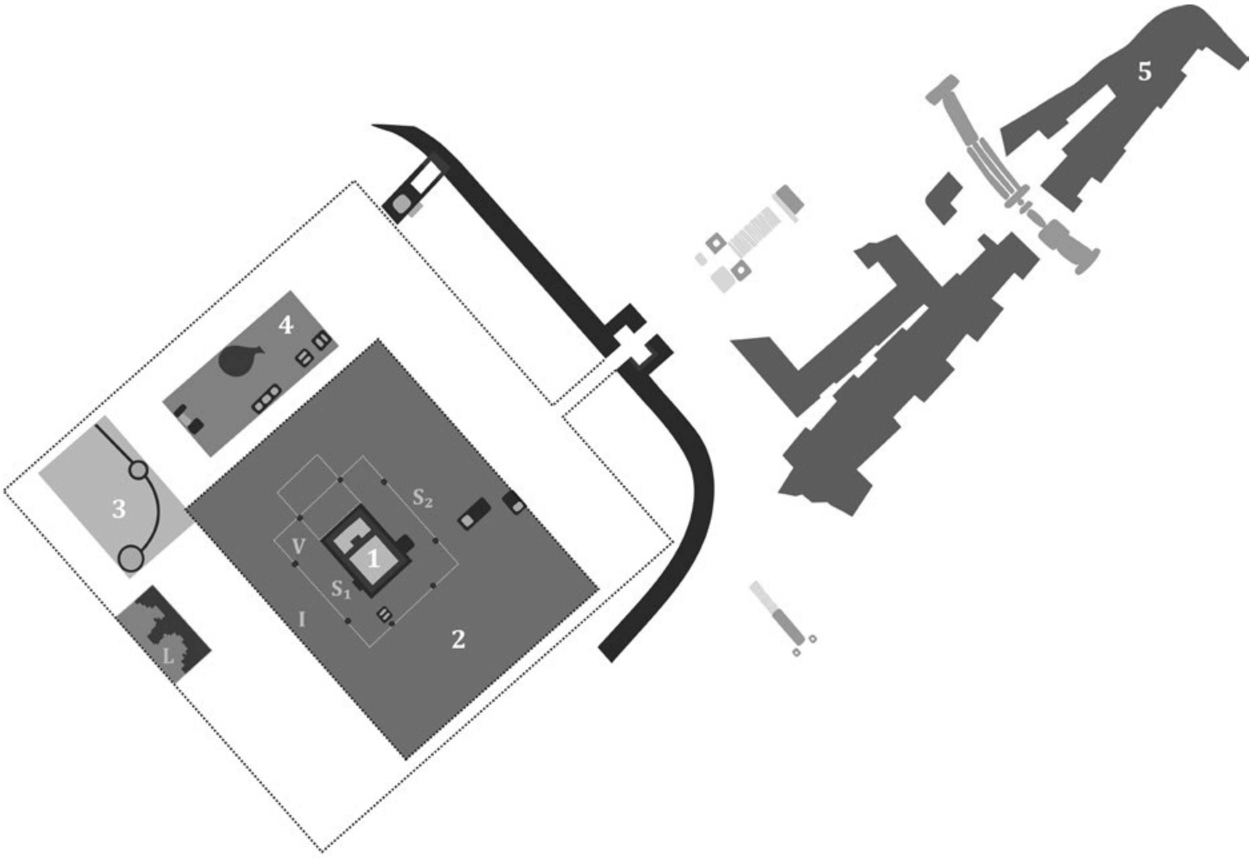

Figure 15.5. Plan of the Early Dynastic E$_2$-ninnu religious complex of Ningirsu featuring the Construction of Ur-Nanše Eš$_3$-Gir$_2$-su (1), the post-Ur-Nanše cult-platform (2), the well pu$_2$-šeg$_{12}$ and kisal-dağal of E-anatum (3), the esplanade of En-metena giguna (4), the Lagaš II temenos-enceinte of Gudea bad$_3$ iri-ku$_3$ (5), and the provenance of ritual artefacts, such as the Stele of the vultures of E-anatum (S_1-S_2), the Votive plaque of Ur-Nanše (V), the Inscribed mace of Me-silim (I), and the Liturgical vase of En-metena (L).

related and plebeian large-scale districts (i.e., the most part of the southern area). In the pre-Sargonic epigraphic records — essentially the economic corpus from the queen's manorial estate — at least three gates designated as abulla (written in the cuneiform texts as a-bul$_5$-la) and six other as ka$_2$ are attested. And if the former term abulla expressed during the Neo-Sumerian Period by the logogram KA$_2$.GAL (i.e., the 'great-gate') appears to differ from the latter term (ka$_2$, translated simply 'gate') on the basis of scale and complexity, both may in fact designate in all likelihood in the Pre-Sargonic documents the same architectural reality, that is, a defended gate (e.g., the pre-Sargonic ka$_2$-sur-ra is later designated as an abulla-type city gate in the Ur III Period) (cf. Edzard 1997: 147, E3.1.1.7.51.10).

Of the three recorded a-bul$_5$-la gates in Early Dynastic times — the a-bul$_5$-la-^{d}Ba-U$_2$, the 'gate of Ba-U$_2$', the a-bul$_5$-la-^{d}Nin-ğir$_2$-su, the 'gate of Ningirsu', and the a-bul$_5$-la-e$_2$-[ki] — only the first two may be but speculatively topographically localised: the a-bul$_5$-la-^{d}Ba-U$_2$ in the vicinity of the temple of Ba-U$_2$, perhaps West of the so-called mound of the *Palais* (Tell A, cf. below), maybe the *Porte du Diable* (Tell P-P'); and the a-bul$_5$-la-^{d}Nin-ğir$_2$-su logically nearby the temple of the city-state tutelary deity, that is, in the environment of the mound of the *Maison des fruits* (Tell K). Since such hypotheses remain speculative, it might be that, inversely, the gate excavated in the Tell P-P' matches the a-bul$_5$-la-^{d}Nin-ğir$_2$-su. As for the other ka$_2$ gateways, only the ka$_2$-sur-ra can be rather confidently identified with the northeastern entrance-like feature of the 'sacred city' (iri-ku$_3$) — as already posited by Cros and Heuzey — near the so-called mound of the *Grandes briques* (Tell B) (cf. Cros 1910: 299). As regards to the royal inscriptions, both the Ur-Nanše's limestone slab found at Lagaš (present day al-Hiba) commemorating the construction of the Bagara (ba-gara$_2$) temple, and a stone foundation found at Girsu, refer to a rather enigmatic 'Battle gate' (ka$_2$-me), perhaps in reference to a real battle fought by the Lagaš phalanx before a gate of Girsu (cf. Frayne 2008: 90 for the identification of this gate, p. 91, E1.9.1.6a: 97, E1.9.1.10). Several of Iri-KA-gina's official inscriptions merely deal with the social-economic aspects of defended gates: 'He (Iri-KA-gina) removed the safe passage toll of the great gate for the pair of workers (…)' (Cf. Frayne 2008: 264, E1.9.9.1), another royal inscription — a recension of the ruler's Reform texts — also mentions that 'Indemnity payments for (possession) of stolen goods have been abolished; lost goods are (now) hung at the city gate' (cf. Frayne 2008: 273, E1.9.9.3).

The ceremonial landscape of the city-state's pantheon

Excavations in the so-called mound of the *Maison des fruits* (Tell K) by Sarzec — the first-tier mound of the site of circa 14 metres high and covering an area of circa 6500 square metres — revealed the remains of a religious complex belonging to Ningirsu, the Lord of Girsu, the divine proprietor of the city-state. Probably founded in the Early Dynastic II or IIIa Period (i.e., prior to the reign of Ur-Nanše, cf. below), the temple developed in the course of the Early Dynastic III Period into a multi-purpose self-contained cultic unit, constructed on a large-scale platform accessible by monumental-like stairways and surrounded by an oval-shaped temenos-enclosure pierced by a simple-type chambered gate; it included the main sanctuary consisting of an enclosed bi-partite rectangular shrine and portico, its corners roughly oriented to the cardinal points, elevated on a high terrace, and it comprised all the offices, subsidiary services, and other facilities necessary for the cult of the tutelary deity (cf. Cros 1910: 11–15, 68–89; Heuzey 1900; Parrot 1948: 54–68; Sarzec and Heuzey 1884–1912: 68–69, 406–424).

If the sacred precinct and peripheral space also yielded a wealth of truly exceptional monuments of Sumerian art, such as the well-known limestone relief-carved plaque of the *Figure aux plumes*, the Stele of the Vultures, etc. (cf. Parrot 1948: 69–124), and, thus, has been the subject of plethora of studies, including on the reconstruction of the immensely problematic stratigraphic pseudo-sequence of temple structures, a lengthy discussion in particular of the latter clearly is beyond the scope of the present article (cf. Crawford 1987: 71–76; Forest 1999: 5–31; Huh 2008: 83–153; Marchesi and Marchetti 2011: 38–44). One may simply recall that at least six main phases pertaining to the Early Dynastic Period have been posited for the central area of the mound of the *Maison des fruits*: the first three phases belonging to a pre-Dynastic I epoch, the fourth phase may be contemporaneous to the reign of the king (lugal) Me-silim of Kiš (Lugal- ša$_3$-ENGUR ruler (ensi$_2$) of Lagaš),[5] the fifth phase dating to the reign of Ur-Nanše, and the last pre-Sargonic phase corresponding to either a later period of that ruler or perhaps to the reign of E-anatum.

Figure 15.6. Archaic bas-relief of the *Figure aux plumes* recording the earliest known occurrence of the sanctuary of Ningirsu (E$_2$-^{d}Nin-g̃ir$_2$-su).

If the above mentioned hypothesis advanced by Falkenstein (1966: 121, 143) of a fundamental distinction between the iri-ku$_3$ and the e$_2$-ninnu appears very likely — that is, the holy precinct spatially encompassing Ningirsu's temple — it is also clear from Parrot's (1948: 58) suggestion, on the basis of the cuneiform evidence predating the reign of En-anatum I, that the latter was called during the reign of Ur-Nanše eš$_3$ G̃ir$_2$-su and e$_2$-^{d}Nin-g̃ir$_2$-su, which might have included or been the *saint des saints*. In fact, the earliest known archaic occurrence of the e$_2$-^{d}Nin-g̃ir$_2$-su may be found on the bas-relief of the *Figure aux plumes* (cf. Gelb, Steinkeller, and Whiting, 1991: 67, ELTS 18, Revers, III. 4: NIN E$_2$ G̃[IR$_2$ SU ?]), while the royal inscription of Me-silim of Kiš contemporary of Lugal-ša$_3$-ENGUR incised on a colossal stone mace-head — although referring rather vaguely to several constructions dedicated to Ningirsu — confirms that the development of the pre-Sargonic sacred precinct, is prior to the reign of Ur-Nanše (cf. Frayne 2008: 70, E1.8.1.1: 'Me-silim, king of Kiš, temple builder for the god Ning̃irsu'). Another indication of this terminus ante quem is the discovery under the so-called construction of the latter ruler of several cuneiform tablets dated to the Fara epoch and related to cultic offerings, therefore emphasising the ancient religious character of the area (cf. Krebernik 1998: 376).

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[5] Marchesi, G. 2011: 40 suggest reading Lugal-ša$_3$-dag̃al.

Yet, clearly Ur-Nanše initiated, through the constant remodelling of the precinct, an aedilship-like policy, which was continued by the dynasty's successors that, according to the first ruler's propagandistic inscriptions, focused especially on the main sanctuary of Ningirsu, the eš$_3$-G̃ir$_2$-su/e$_2$-^{d}Nin-g̃ir$_2$-su (cf. Frayne 2008: 44, E.1.9.4.7: 95, E1.9.4.8: 96, E1.9.4.9). However, Ur-Nanše is also responsible for the construction of at least two other important temples in Girsu, the e$_2$-TAR (that is, the temple of Ba-U$_2$: cf. Frayne 2008: 114, E1.9.1.29), probably situated in the iri-ku$_3$ (see below) and equivalent to the later e$_2$-^{d}Ba-U$_2$ renovated by Iri-KA-gina, and the šeš-e-g̃ar-ra, the temple of Nanše, originally located outside the boundaries of the 'holy quarter' (Tell L, cf. below) (cf. Frayne 2008: 86, E1.9.1.4, 11, E1.9.1.5, bii3, E1.9.1.20, ii9, E1.9.1.23, i10, E1.9.1.30°). Several other public and secular constructions may also be attributed to his reign on the basis of in situ epigraphic finds, such as the so-called *Région des bassins*, and perhaps the *Grand escalier*, the monumental-type stairway leading to the temple of the chief deity Lord of Girsu.[6]

Of the reign of A-kurgal only scarce evidence is available, whereas that of E-anatum yielded a wealth of information related in particular to the plausible enlargement of the religious complex of the mound of the *Maison des fruits* (Tell K): about 25 metres northwest of the central shrine of the latter E-anatum constructed in Ningirsu's broad courtyard (i.e., the kisal-dag̃al), is a large 'brick-(lined) well' (pu$_2$-šeg$_{12}$) made of plano-convex inscribed bricks (cf. Sarzec and Heuzey 1884–1912: 416–419; Frayne 2008: 155–158, E1.9.3.9. iii, 2). Because the kisal-dag̃al is not recorded in Ur-Nanše's royal inscriptions and since E-anatum, as already mentioned, also boasts of having (re)-constructed the 'enceinte of the holy precinct', it appears that in the course of that ruler's reign, the e$_2$-ninnu had probably been considerably restructured. En-annatum I apparently left only few architectural features to posterity, and was likely responsible for the construction of a terrace situated in the vicinity of the *Grand escalier* (Tell I-I'), an attribution based on an in situ brick bearing the inscription, 'He (En-annatum I) brought white cedars down to him (Ningirsu) from the mountains. When he had filled in the temple with them he laid its roof thatch (?) of white cedar (branches) for him' (cf. Frayne 2008: 174, E1.9.4.3).

En-metena's royal inscriptions found on varying types of ex-votos, such as foundation tablets, door-sockets, and bricks, commemorate the construction of the so-called Reed shrine of Ningirsu's giguna (cf. Frayne 2008: 210, E1.9.5.8), which is to be found either as eš$_3$-gi-gi-gu$_3$-ma-^{d}Nin-g̃ir$_2$-su or in the shorter form eš$_3$-gi-^{d}Nin-g̃ir$_2$-su-ka.[7] The latter variant is only attested in one inscription for which five exemplars consisting of bricks have been uncovered, one of them in the so-called Massif of En-metena,[8] while the former occurs in three inscriptions, one of them coming from the so-called Esplanade d'En-metena.[9] The Massif of En-metena was probably a large-scale retaining wall or the remains of a cultic sub-platform, located at the westernmost edge of the sacred precinct e$_2$-ninnu (circa 15 metres west of the temple of Ur-Nanše, and a few metres south of the well of E-anatum) (cf. Parrot 1948: 65; Forest 1999: 17). Also, the well-known Silver Vase, depicting a representation of the lion-headed eagle (Anzu) and bearing an inscription of En-metena, and a bitumen stone (possibly slate) recording the temple administrator Dudu's fashioning of a plaque of stone from the city URU×A, both discovered in the area of the Massif of En-metena, were devoted to the patron god of the e$_2$-ninnu (respectively Frayne 2008: 232–233, E1.9.5.7: 233, E1.9.5.28). One would infer that the holy district included the giguna of Ningirsu as was the case later under the reign of Gudea (see below) (cf. Falkenstein 1966: 135).

As already mentioned, the so-called Esplanade of En-metena included door-socket inscriptions connected with the giguna shrine. The latter also encompassed a 'brewery' (e$_2$-bappir) and a 'coach-house' (e$_2$-$^{g̃eš}$gigir$_2$-ra) for the god Ningirsu (cf. Frayne 2008: 214–215, E1.9.5.12 for the e$_2$-bappir and pp. 217–218, E1.9.5.14, for the e$_2$-$^{g̃eš}$gigir$_2$-ra. The fact that inscriptions dealing with the construction of these structures were found in situ north of the temple of Ur-Nanše suggests that they lay close to one another in that area. Also, according to Frayne (2008: 217), the e$_2$-bappir and e$_2$-$^{g̃eš}$gigir$_2$-ra of Ningirsu's giguna may have been restored by Gudea as suggested by a passage in Gudea Cylinder A where mention is made of a nesag̃, perhaps 'wine cellar(?)' or 'sacristy,' together with a brewery, storehouse, and coach house of the god Ningirsu. A correlation of the En-metena and Gudea corpora would assume

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[6] See the inlay pearl published in Frayne 2008: 82, E1.9.1.1 (with a wrong indication regarding the origin of the artefact). Cros 1910: 102–104; Huh 2008: 143 and 280 assigns the trenches 2 and 4, matching the so-called *Région des Bassins* to this very first ruler and to the First Dynasty of Lagaš. With regard to the so-called *Grand Escalier*, see Huh 2008: 78–80.

[7] Cf. Frayne 2008: 210. Since the pioneering study of Falkenstein, the 'Reed shrine of Ningirsu' (eš$_3$-gi-^{d}Nin-g̃ir$_2$-su-ka) is considered to be identical with the term eš$_3$-gi-gi-gu$_3$-na: see Falkenstein 1966: 135.

[8] Cf. Frayne 2008: 212, E19.5.11, iii 1–2; notwithstanding the introductive observations of the same scholar, the provenance of four of those bricks is seemingly unspecified in the archaeological reports, see Huh 2008: 455 (EŞ 2507): 405, 512, 515 (AO 11816 = TG 464, TG 573 and TG 575); only the exemplar No. 2, AO 355 comes from the Massif of En-metena (see Huh 2008: 97 and Sarzec and Heuzey 1884–1912: 419).

[9] Cf. Frayne 2008: 210, E1.9.5.8, iii. 3–4-iv.1: tablet foundation EŞ 9577, provenance seemingly unspecified; p. 211, E1.9.5.9, 9–10, door-socket BM 90932, provenance unspecified; p. 211, E1.9.5.10, 4–5, door-sockets EŞ 388–389, uncovered in the Esplanade of En-metena; cf. Sarzec and Heuzey 1884–1912: 420, referring to the door-socket En-metena 2, pl. xlvi in the second volume (= EŞ 388–389, with parallels from unknown provenance, VAT 3311 and a fourth exemplar in the Princeton Art Museum).

that the Gudea inscription contained a topographical description of the temple precinct of Ningirsu. It also coincides with the mention together in Girsu of a 'coach house' and 'brewery' in an inscription of Iri-KA-gina. Also, a clay cone found at Ur (present-day Tell el-Muqayyar) bears an inscription recording En-metena's embellishment of Ningirsu's e$_2$-ninnu precinct (cf. Frayne 2008: 207–208, E1.9.5.6).

Of En-metena's successors, only scarce evidence of wide-scale constructions in the cultic district of Girsu is attested until, of course, the reign of Iri-KA-gina. En-anatum II left only one royal inscription on several door-sockets which records the ruler's restoration of a 'brewery' (e$_2$-bappir) for the god Ningirsu, probably the one already mentioned, constructed by En-metena in the giguna area. Although a very large number of administrative documents belong to Lugal-Anda's reign, only one official inscription of that sovereign found on a brick mentions that 'He (Lugal-Anda) erected a monument (stele) and named it Ningirsu is the Lord Eternally Exalted in Nippur' (cf. Frayne 2008: 242–248, E1.9.8.2).

Iri-KA-gina's royal inscriptions found on stone tablets, door-sockets, and bricks refer to the construction of several shrines inside the e$_2$-ninnu encompassing the entire mound of the *Maison des fruits* (Tell K) as well to a possible restoration of the whole precinct consecrated to Ningirsu (cf. Frayne 2008: 267, E1.9.9.2, iii. 8', in which the e$_2$-ninnu shrine is connected with the 'Canal flowing toward Niĝin/Nina'), and of the 'coach-house' and 'brewery,' both probably located next to the giguna shrine, north of the inner sanctum of the temple district (cf. Frayne 2008, p. 280, E1.9.9.6, ii.3 and p. 281, 39 for the 'coach-house'; Frayne 2008: 274, E1.9.9.3, v.2' and p. 280, E1.9.9.6, ii.6 for the 'brewery'). The following temples can therefore be located in the 'sacred city' (iri ku$_3$): the shrine of the goddess Ba-U$_2$ (simply designated by the term e$_2$) is probably identical with the e$_2$-tar-sir$_2$-sir$_2$ later mentioned in documents from the time of Gudea,[10] the e$_2$-me-ḫuš-gal-an-ki consecrated to the god Ig-alim (cf. Frayne 2008, E1.9.9.2: 267; E1.9.9.3: 274; E1.9.9.6: 280; E1.9.9.7: 281), the e$_2$-ki-tuš-akkil-li$_2$-ni, where the god Šul-ša$_3$-ga-na was worshipped (cf. Frayne 2008, E1.9.9.2: 267; E1.9.9.3: 274; E1.9.9.6: 281; E1.9.9.7: 280; E1.9.9.10: 290), the temple of Lama-sa$_6$-ga, and, within it, the shrines of the divinities Za-za-ru$_{12}$, Ni$_2$-pa-e$_3$ and Ur-nun-ta-e$_3$ (cf. Frayne 2008, E1.9.9.2: 267 and maybe E1.9.9.3: 275, in which the temple names can be restored).

Excavations far beyond the temenos-perimeter of the Ningirsu religious complex of the 'holy city' (iri-ku$_3$) (that is, in the so-called mound of the *Logettes vides* (Tell L) in the southwesternmost part of Tello), revealed first by Sarzec and later by Genouillac, as already noted, several mudbrick structures perhaps belonging to a temple construction, located east of the likely Early Dynastic archaic enceinte. The large-scale monument, of which unfortunately no plan is available, included several inscriptions found on varying types of ex-votos, such as pre-Sargonic bricks and door-sockets, and Ur III clay cones from the time of Šulgi, connected with the construction of the temple of Nanše, called šeš-ĝar-ra (cf. Frayne 2008: 85–86, E1.9.1.4, 11 for the reign of Ur-Nanše. See also E1.9.1.5, bii3; E1.9.1.20, ii9; E1.9.1.23, i10; E1.9.1.30a) and pp. 224–225, E1.9.5.20 for the reign of En-metena). Hence, it appears that the temple of Nanše was founded by Ur-Nanše at the periphery of the city, restored by En-metena, and later rebuilt by Šulgi, with the name e$_2$-šeš-ĝar-ra.

The logistical infrastructure of the ancient waterways

Several soil marks, characteristic of archaic watercourses and palaeochannels, have been identified both on the post-World War I aerial photography and the 1968 space imagery of Girsu: the main palaeo-canal, which is between circa 15 and 20 metres in width and runs from northwest to southeast on the entire surface of the 'turtleback' and, in the area of the proper complex of mounds, along the slope of the eastern tells (i.e., east of the extra-muros district), and other secondary canals of about 10 metres in width situated to the north of the site. Some of these relict hydraulic features likely correspond to the sub-surface traces of the city harbour and associated waterways reconstructed by Cros in the area situated nearby the 'holy city' (iri-ku$_3$), that is, in the vicinity of the so-called mound of the *Grandes briques* (Tell B) (Cros 1910: 64, 298–299). That the principal palaeochannel, probably a branch of the ancient Tigris (Idigna, see below), is today raised a few metres above the surrounding Holocene plains may be explained because of massive aeolian erosion (i.e., deflation) (T. Wilkinson and J. Jotheri 2014, pers. comm). Careful analysis of its particular course of circa 3000 metres detectable on RAF and CORONA photographs led to the important observation that at the level of present-day Tello, this archaic first-tier waterway crossed the eastern tells roughly from northwest to southeast exactly through the so-called *Construction* énigmatique exposed by Genouillac and Parrot (cf. Genouillac 1936: 16–17; Parrot 1948: 211–219).

Excavations in the eastern tells in the pre-World War II era revealed indeed the remains of this really unique monument of Sumerian public architecture, that is, roughly circumscribed in a circa 20 by 40 metres rectangular base northwest-southeast parallelepiped of about 8 metres in height, possibly constructed in

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[10] Cf. Frayne 2008: 259, E1.9.9.1, i10; see also the following royal inscriptions: E1.9.9.2, i10, E1.9.9.3, v8', and E1.9.9.6, iii5. According to Genouillac (1930a: 17–18 and 1930b: 170–171) the Ba-U$_2$ temple may have been situated at the so-called mound of the *Quatre seuils* (Tell G).

Figure 15.7. Modern high resolution space photography of Tello/Girsu including the *Structure* énigmatique in fact a bridge over a palaeochannel (1), the large-scale gully perhaps the ferry terminal kar-ma$_2$-addir$_x$ (2), the holy-city Iri-ku$_3$ (3), the Tell L, probably the šeš-e-g̃ar-ra shrine of Nanše (4), and the pre-World War II French archaeological dig house (5).

the Early Dynastic Period on the basis of plano-convex archaic bricks, and renovated several times in the course of the Ur III and Larsa Periods. The epigraphical material, dating only from the Neo-Sumerian Period, consists noticeably of a brick of the ruler Pirig̃-me$_3$, which refers to the construction of a weir, Sumerian g̃eš-keš$_2$-ra$_2$ (Edzard 1997: 13, E3.1.1.2.1; see Parrot 1932: 55), clay cones of Gudea related with the construction of temples dedicated to the divinities Ig-alim and seemingly Šul-ša$_3$-ga-na,[11] a steatite statue with human-headed bull on behalf of the ruler Ur-GAR (cf. Edzard 1997: 190–191, E3.1.1.9.3; Parrot 1932: 55–56), and 90 tablets (cf. Parrot 1932 : 57). If the role of the enigmatic structure has been a matter of considerable scholarly debate since its discovery — alternately hypogeum, religious complex, reservoir construction, and water regulator (cf. Barrelet 1965: 100–118; Genouillac 1936: 16–17; Jacobsen 1960: 174–185; Parrot 1948: 211–219; Pemberton *et al.* 1988: 207–221; see Wilkinson 2013: 33–54) — both the re-interpretation by Margueron (2005: 63–92), using in particular the 1930s field archives, and the objections raised against the previous hypotheses appears rather convincing: the accumulation of alluvial deposits and the structural organisation of this large-scale hydraulic feature made of baked-bricks and bitumen, clearly suggest a bridge over a palaeochannel interpretation.

According to the royal inscriptions and administrative documents of the First Dynasty of Lagaš, the city included a major waterway, the i$_7$-Nig̃in$_6$^{ki}-DU-a, the 'Canal which goes (to the city of) Nig̃in/Nina (present-day Zurghul)'[12] — the crucial resource and principal

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[11] On the royal inscription related to Šul-ša$_3$-ga-na, cf. Edzard 1997: 162–163, E3.1.1.7.73. Other exemplars of the same inscription were also seemingly found by Sarzec in other sectors. The inscription referring to the construction of Ig-alim's temple cannot be clearly identified since the only royal document related to this god published in Genouillac 1934–1936, 2: 133, is the text bearing the excavation number TG 3960 (AO 12771), cf. Edzard 1997: 178, E3.1.1.7.98.

[12] Nig̃in is here preferred to Nina.

lifeline of integration of the Girsu-Lagaš city-state in the pre-Sargonic and Ur III Periods — and other secondary canals, including the i$_7$-tur-G̃ir$_2$-su^{ki}-i$_3$-tuku-a, the ‘Little Canal which belongs to Girsu.’ Iri-KA-gina’s official inscriptions found on clay cones bearing the well-known recension of the so-called Reform texts mention that: ‘For the goddess Nanše, he (Iri-KA-gina) dug the Nig̃in-DU canal (…), and extended its outlet to the sea’ (cf. Frayne 2008: 259, E1.9.9.1, ii8). Furthermore, Iri-KA-gina dug for the god Ningirsu the ‘Little Canal which belongs to Girsu’ and restored its former name, calling it ‘the God Ningirsu received (his) authority from Nippur. He extended it to the Nig̃in-DU-a canal’ (cf. Frayne 2008: 265, E1.9.9.1, xii30–31; see Carroué 1986: 19). Also, another royal inscription found on a brick fragment refers to the ruler’s construction of a ‘reservoir (g̃eš-keš$_2$-ra$_2$) of the Canal which goes to Nig̃in (…) out of 432,000 fired bricks and 1820 standard gur sag̃-g̃al$_2$ (2649.6 hectoliters) of bitumen’ for the god Ningirsu (cf. Frayne 2008: 282–283, E1.9.9.8). Interestingly, this term is identical with the name of the structure built by Pirig̃-me according to the inscription found in the aforementioned monument interpreted as a bridge. The g̃eš-keš$_2$-ra$_2$ built by Iri-KA-gina may therefore also designate the bridge.[13]

If the identification of the mega-canal i$_7$-Nig̃in^{ki}-DU-a with the northwest-southeast major waterway flowing east of present-day Tello — that has been mapped by means of remote-sensing techniques from RAF and CORONA photographic interpretations — appears very likely, the localisation of the secondary canal i$_7$-tur-G̃ir$_2$-su^{ki}-i$_3$-tuku-a should be subject to caution (cf. Carroué 1986: 15, 19–21). Yet, on the basis of its former name, the ‘Little Canal which belongs to Girsu,’ it seems rather likely that this second-tier water-supply feature flowed through part of the city. Perhaps it coincides today with the large-scale wadi-like gully running from north to south in the western part of the site flanked by more or less linear levee-like features, and precisely in alignment with one of the above-mentioned archaic watercourses identified on the RAF and CORONA imagery.

One may argue, moreover, that these rectilinear sorts of embankments bordering the north–south major ravine, southwest of the ‘holy precinct’ (iri-ku$_3$), could also be connected to the construction of intramural dykes (Sumerian eg$_2$) recorded in the Early Dynastic cuneiform archives. One tablet of Lugal-an-da’s reign mentions the length of 80 ninda-DU (i.e., 480 metres, after re-interpretation of broken cuneiform signs) for a dyke (eg$_2$) erected between the bad$_3$ e$_2$-mi$_2$, the ‘enceinte of the e$_2$-mi$_2$,’ that is, the seat of the estate’s bureaucratic and ideological apparatus of the queen Para$_{10}$-nam-tar in the ‘sacred city’ (iri-ku$_3$) — identical with the later temple of Ba-U$_2$ (e$_2$-^{d}Ba-U$_2$) — and the e$_2$-^{d}Nanše, the temple of Nanše, probably identical with the šeš-g̃ar-ra situated, as already mentioned, in the mound of the *Logettes vides* (Tell L) (cf. Selz 1995: 206). And interestingly enough, the distance between the *Porte du Diable* (Tell P-P’), northwest of the iri-ku$_3$ religious complex, perhaps the gate of a-bul$_5$-la-^{d}Ba-U$_2$ (the ‘gate of Ba-U$_2$’), and the šeš-e-g̃ar-ra shrine of Nanše (Tell K), both situated precisely at both ends of the large-scale gully-like feature is about 500 metres.

Other pre-Sargonic epigraphic documents also provide information relating to large-scale hydraulic features connected to the city of Girsu. A pre-Sargonic inscription found on a boulder records various construction works of both En-metena and the temple administrator Dudu, including the kar-ma$_2$-addir$_x$-G̃ir$_2$-su^{ki}, the ‘Girsu ferry terminal’ (cf. Frayne 2008: 231–232, E1.9.5.27, III 9–10). Because on the basis of later Gudea cuneiform sources the principal quay of the city was situated in the vicinity of the ka$_2$-sur-ra defended gate and perhaps the bad$_3$ iri-ku$_3$, the ‘enceinte of the holy precinct’, it appears likely that from the Early Dynastic Period to Ur III times it was situated northeast of the iri-ku$_3$ exactly in the area where Cros identified the city harbour from sub-surface traces in 1904. Also, the five perforated cyclopean boulders unearthed by Cros (cf. Cros 1910: 298–299) northeast of the so-called mound of the *Grandes briques* (Tell B) — probably proto-anchors for boats (Sumerian ma$_2$) — appear indeed rather comparable to the well-known Byblos and Ugarit stone anchors of respectively the temple of the Obelisks and the temple of Ba’al, and therefore their provenance seems rather consistent with the identification of an archaic port nearby the ‘sacred city’ (iri-ku$_3$). Perhaps the ‘Girsu ferry terminal’ (kar-ma$_2$-addir$_x$-G̃ir$_2$-su^{ki}) today topographically corresponds to the northern wide-scale thalweg-like feature already mentioned above — located between the multi-mounded first-tier complex of the site (Tell A, Tell B, Tell K, Tell I-I’, etc.) and the Eastern tells — and probably connected to one of the secondary palaeochannels detectable on the pre-World War II British air services’ photography and the American 1968 space imagery.

The urban scenography of a sumerian religious power

In conclusion, the re-investigation of the topographic layout of Tello (ancient Girsu) from an interdisciplinary approach by combining the Early Dynastic archaeological evidence, the epigraphic records from the time of the First dynasty of Lagaš, and the

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[13] Other structures named g̃eš-keš$_2$-ra$_2$ occur in Pre-Sargonic inscriptions from Lagaš, which nevertheless refer to distinct constructions: cf. Frayne 2008: 148, E1.9.3.5, vii 10 (under E-anatum, structure called Lum-ma-gen$_7$-du$_{10}$ and consecrated to Ningirsu); Frayne: 181, E1.9.49, v 8 (under En-anatum I, for Lugal-uru$_{11}$); Frayne 2008: 229, E1.9.5.26, iv 2, vii 5, viii 4 (under En-metena, structure called Lum-ma-gen$_7$-du$_{10}$ and consecrated to Ningirsu).

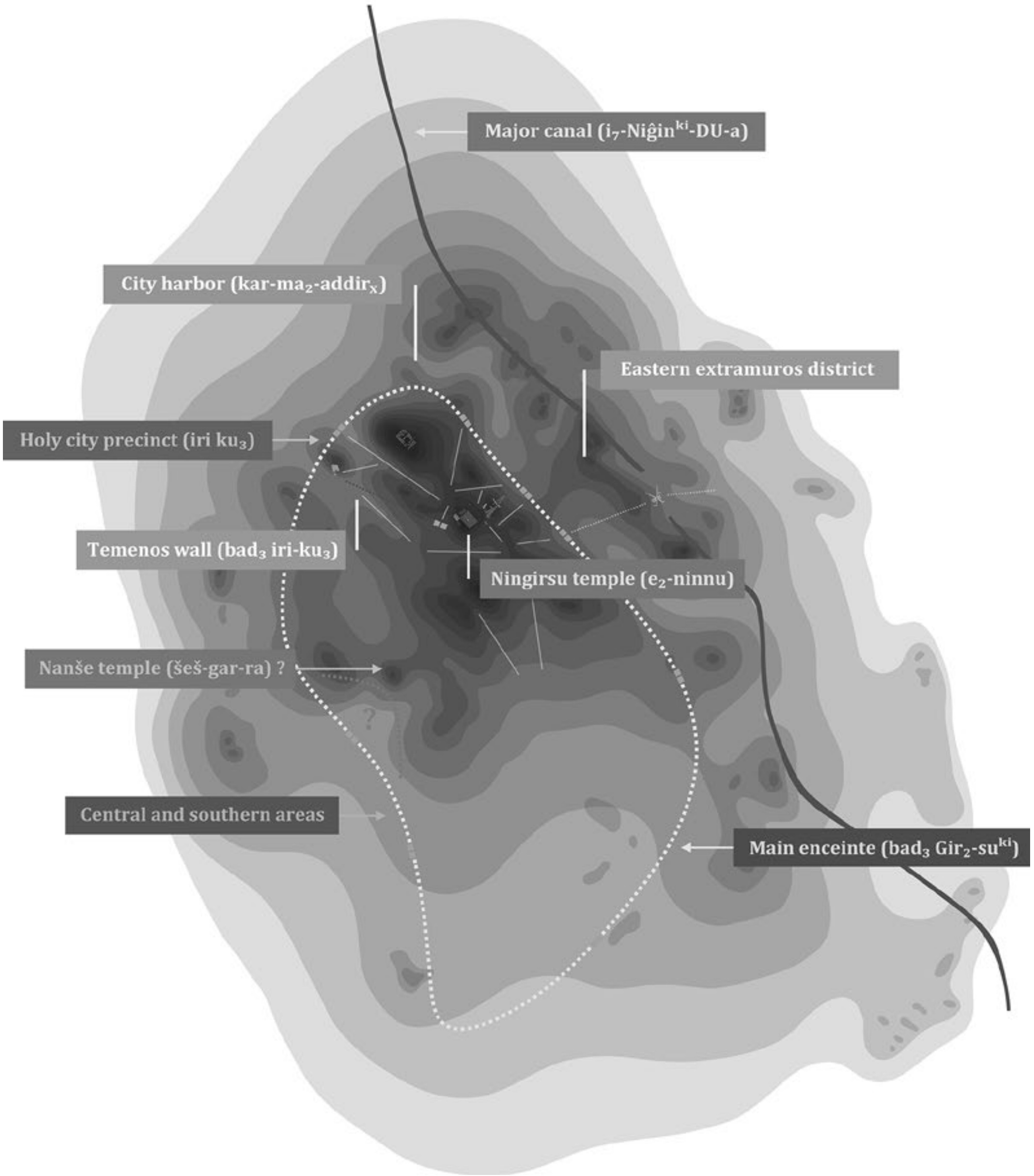

Fig. 15.8: General layout of the Early Dynastic religious megapolis of Tello/Girsu reconstructed by combing archaeological evidence, epigraphical sources, and satellite imagery.

declassified Cold War-era satellite imagery, provides important insights into the institutional form of the religious metropolis of a Sumerian city-state. The circa 130 hectares pre-Sargonic mega-city consisted of three principal multi-purpose spaces connected to a complex network of canalisation (and waterways), either water-supply installations or water-transport features: (1) an elevated sacred walled-precinct of large-scale and ‘elite-related’ cultic architecture (i.e., mutatis mutandis, an acropolis), including the major religious complex of the patron deity Ningirsu probably standing on a rather elaborately prepared high terrace and consecrated platform enclosed by an oval-temenos; (2) a large-scale defended space of combined pre-planned religious areas (e.g., the peripheral temple of Nanše), secular political agro-managerial hubs — perhaps the so-called mound of the *Tablettes* (Tell V) — and, of course, presupposed (probably plebeian) residential areas that probably grew organically; (3) an extramural district consisting of other domestic quarters and maybe storage facilities set along a mega-canal, the principal nexus serving the major centres of the city-state. Also, the spatial (perhaps cognitive) representation of the centre of Ningirsu cult may be perceived as a symbolic and three-dimensional succession of constructions and quarters, not unlike a Russian doll paradigm (i.e., following the well-known Matryoshka principle): the core sanctum sanctorum is very likely the shrine of Girsu (eš$_3$-G̃ir$_2$-su interchangeable with e$_2$-^{d}Nin-G̃ir$_2$-su), also called e$_2$-ninnu, which was situated inside the holy precinct (iri-ku$_3$), the holy precinct being part of the city of Girsu (G̃ir$_2$-su^{ki}) (see Ess 2013: 59–84). Of course, the overall multi-mounded and multi-vallated configuration reflects both phenomena of the vertical stratification of politically organised societies and the horizontal separation of space, particularly diagnostic features of the internal organisation of Early Dynastic Sumerian cities.

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Resilient Landscapes:
The Evolution of Riparian Landscape Studies in Southern Iraq

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Landscape histories

This chapter explores the history of studies and reconstructions of the Tigris-Euphrates river systems in Southern Mesopotamia, and draws a disruptive conclusion: that the Akkad-dominated and static view of the Lower Mesopotamian plain must end. No representation of river courses as single black lines on white maps is ever fully representative of contemporary riparian dynamics anywhere, but in regions (like Babylonia) where understanding coupled anthropogenic and natural systems is essential to understanding the *longe durée* of enduring human settlement and civilisation, such representations fundamentally obscure both critical mechanisms, and the critical importance, of watershed transformations across space and through time.

Landscape and archaeology

Landscape studies have a long history in Middle Eastern archaeology, even if use of the term 'landscape archaeology' to describe these activities is relatively recent. Thousands of years of continuous settlement there has left us a documentary palimpsest — a contemporary landscape comprising many partial, superimposed layers of relict features capped by a spatially continuous, but temporally discontinuous, blanket of archaeological material visible on the surface (Cherry 1983; Wilkinson 2003: 5). Tony Wilkinson's innovative contributions to that body of work, and on-going efforts by his former cadre of graduate students, grew from his pioneering introduction of advances in multi-scalar analysis to that region. These synthetic examinations of natural and cultural processes, conducted both on the ground and via remote sensing, have resulted in significant breakthroughs toward understanding complex phenomena of human-environment interactions.

From the mid-19th through the early-20th centuries, travellers and tourists, amateur archaeologists, and colonial government employees made initial forays toward understanding the abiding history of human-environment relations in the Middle East. They recorded general descriptions of various aspects of the territories through which they passed, as well as life ways of those who inhabited them. These antiquarians and sojourners marvelled at the density and variety of ancient remains visible on the modern surface. They lamented their ongoing destruction and inaccessibility. They wondered how once-great civilisations arose in areas that now, in their absolute desiccation, seemed most forbidding and unforgiving. They set about recording standing monuments and features using photographs, measurements, sketches, and maps (e.g. Ainsworth 1842; Bell 1907; 1910; Chesney 1868; Layard 1882; Loftus 1856; Rich 1818; Taylor 1865), sinking the roots of later scholarly interest in the landscape context of ancient civilisations.

These early practitioners understood that the deeply layered archaeological record contains evidence for crucial transformations in human history, such as the emergence of the first cities, states, and empires; the spread of long-distance trade networks; the evolution of populations and their demographic changes, and the development of specialised and diversified agro-pastoral economies. What they could not yet realise (or, if they did realise, did not yet have the tools or techniques to address) was that understanding the mechanisms underpinning these evolving institutions and practices requires multi-scalar comparison of human-environment interactions, including interactions within individual sites, the spaces between sites, site networks, and across entire regions — informed by evidentiary data and analyses from other disciplines.

Subsequent historical and archaeological investigations in Mesopotamia attempted to address some of these lacunae. With the addition of palaeobotany, zooarchaeology, and settlement survey to the archaeological cannon, archaeologists of Mesopotamia began to integrate landscape-oriented studies into broader themes of why and how: why the first complex societies arose here, and how the once (presumably) lush and verdant landscape became the depopulated and harsh environment visible today. Among the many historical, ethnographic and archaeological observations of that time, irrigation agriculture — indeed, any harnessing of the power of water and

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directing it to where it was deemed most useful — dominated the overall narrative. Following that early vision, subsequent studies concentrated on the evolution of the Tigris and Euphrates river system as the underlying basis for the development of 'civilisations'. Such studies mapped rivers and canals, depicted as unitary black lines on white backgrounds, and 'dated' them by their proximity to sites characterised by surface scatters of potsherds and other artifacts, periodised from ceramic chronologies anchored in nearest-available excavated contexts (e.g. Adams 1981; Jacobsen 1960).

But Wilkinson taught (and showed) that the surficial presence of innumerable asynchronous features can be attributed to the interaction of (mostly) superficial geologic strata, climatic variables, and hydrological variables, with a wide variety anthropogenic modifications — particularly in cases where those interactions induce episodes of sedimentation and erosion. In the silty alluvial plains, especially during periods of significant change in seasonality, precipitation, and temperature, landscapes associated with a broad range of human activities (such as ancient and modern agriculture, resources extraction, animal husbandry, and infrastructure development) may become profoundly marked, deeply buried, or utterly erased. The resulting patchwork of layered remains thus represents a long-term archive of the broad set of complex relationships between people and their physical and social environments — only a few of which visible on the surface were necessarily contemporaneous, let alone had any particular connection to irrigation.

In the wake of isolation and war, direct investigation of Southern Iraq's environmental evolution, first using the military's stepchildren (satellite imagery and remote sensing), and next the plethora of tools accrued to geology, geomorphology, biogeochemistry, climatology, and other palaeoenvironmental sciences during Iraq's isolation from international science communities, has pushed long-overdue re-analysis of previous material. Not the least of these results is that the static representations of these systems as simple, linear black lines on white pages, drawn from early-20th century intellectual frameworks imported from other contexts, and embedded in theoretical and material models proposed in the later 20th century, must now be irrevocably transformed.[1]

The careful and systematic evidence-based re-analysis described below demonstrates the complexity of the Lower Mesopotamian socio-environmental system, including the dynamic and interlinked movements of rivers, marshes and settlements through time and space. It builds an alluvial scale picture of the ancient Mesopotamian natural and cultural landscape *without artificial boundaries* imposed by archaeological surveys or uneven privileging of archaeological sites where groups of ancient texts have been excavated. Stepping through existing datasets, we present a holistic synthesis, contextualise newly available resources, and suggest pathways to further understand the evolution of the ancient Mesopotamian landscape as fieldwork re-commences.

Landscape and geology

Histories of the Tigris-Euphrates river system in Southern Mesopotamia were constructed from a number of studies with widely variant levels of empirical detail, observational accuracy, and disciplinary perspective (Ionides 1937; Kholy 1952; Lees and Falcon 1952; Le Strange 1905; Macfayden 1938; Soussa and Atkinson 1944/46; Vaumas 1955; Verhoeven 1998; Willcocks 1917; and more recently Wilkinson 2002; 2013). From a natural science viewpoint, both the underlying geology and the fluvial dynamics of the rivers shaped and continue to shape the topography of Southern Iraq. The plain is a tilted basin (geosyncline) that trends northwest to southeast, comprising accumulated soils and sediments eroded and brought down from the uplands of Turkey, Syria, and Iran, by the rivers and their tributaries. Continual sedimentation in this relatively flat basin over millennia has resulted in the visual appearance of little topographic variation within its 444,442 km^2 area. However, there *is* a gentle change in gradient: from 1:10,000–1:15,000 along the alluvial plains, amounting over the course of 445 km (from Baghdad in the north, to Basra in the south) to a 30 m drop in elevation. This change, though slight, results in micro-topographic differences across and along the alluvium that drive alluvial hydrology (Aqrawi *et al.* 2006; Buringh 1960: 35).

As the surface slope of alluvial channels levels off on route to the sea, their beds undergo threshold changes: from braided, to meandering, to straight or sinuous, with the latter in some cases assuming anastomosed, multi-channel patterns. In Mesopotamia, braided channels are typical of the arid uplands, where the Tigris and Euphrates are deeply incised into the Syrian and Arabian plateaus. However, on dropping from the shelf lands into the alluvium, where their slopes abruptly diminish and flows abruptly slow, the rivers drop most of their sediment loads and assume meandering courses within relatively stable banks through a river floodplain. In the upper alluvium, from Baghdad to Kut and Ramadi to Samawa, meandering systems are visible within the relatively narrow belts of both present-day and archaic floodplains. Then, on passing from the upper alluvial trough to the Euphrates sub-zone flatlands, slope falls to less than one-half

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[1] Co-author Pournelle treats this subject at greater length in previous publications.

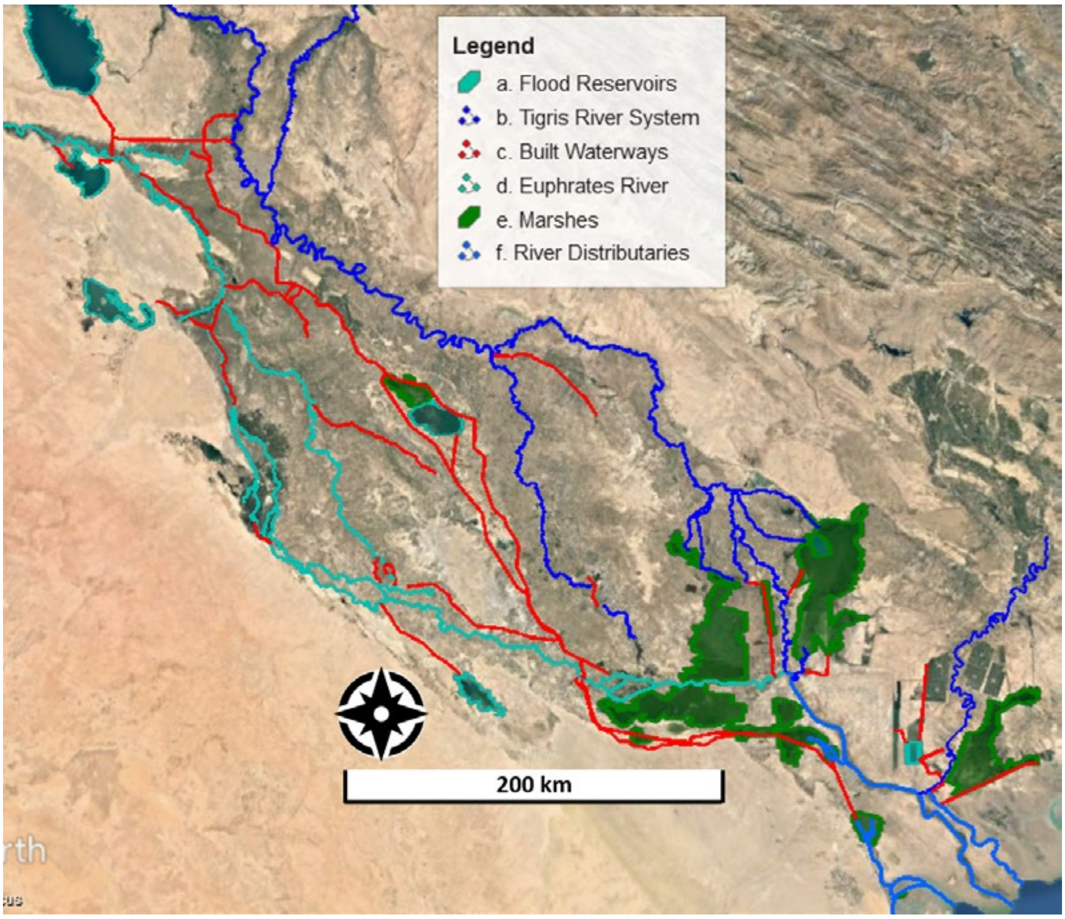

Figure 16.1. Southern Iraq, showing major rivers (natural and man-made) as of Spring, 2020.

percent, and the rivers tend to branch into multiple sinuous distributaries with weak banks.[2]

The Euphrates and Tigris rivers are fed predominantly by spring snowmelt from the surrounding uplands (Jones *et al.* 2008). Due to the tilt and flex of the Mesopotamian basin as it folds beneath the Zagros Mountains, where the rivers enter Iraq from Syria and Turkey respectively, they have initially different morphological characteristics. On debouching onto the alluvium southeast of Habbaniya, the Euphrates River almost immediately splits and rejoins in multiple, anastomosing branches over its 750 km course, eventually reaching the Tigris near Qurna to form the Shatt al-Arab waterway (Figure 16.1). Euphrates channels are characterised by their weak, shallow, but broad natural levees, created by the accumulation of stream-bank soil deposition following each annual inundation. Over time, this process creates a 1–2 m-high, kilometre-wide soil ridge, only slightly elevated above plain level, with the riverbed running along its crest. Soils deposited during levee formation are most agriculturally productive towards the top of the levee, and decrease in agricultural potential down slope (Postgate 1994: 174). In this semi-arid environment, irrigation was, and remains, necessary for cultivating staple grain crops. Because of that elevated riverbed, irrigating Euphrates River levee soils requires only (relatively) shallow incision through the riverbank in order to gravity-feed water downhill into fields.

As the Tigris River makes its away along the eastern flank of the alluvium above Amara, where it finally splays into three cultivable, levee-building courses, it exhibits a different channel morphology. Like the Euphrates, where it initially enters Iraq, it incises into the plain as a fast moving braided river. And, as it emerges onto the alluvium north of Baghdad, it too assumes a meandering course through a shallow valley floor. However, contained by the tectonic trough at the foot of the Zagros piedmont, its bed is not elevated. Rather, where the Euphrates already splits and rejoins

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[2] A full discussion of Mesopotamian alluvial geomorphology lies beyond the scope of this paper, and has been published by the authors elsewhere (Hritz 2005; Hritz and Wilkinson 2006; Pournelle 2003b; 2012). See Verhoeven 1998: 175 (fig. 3) on the interaction of sediment load with stream power, flow velocity, and gradient to determine channel pattern and stability.

among its tenuous banks, Tigris waters flow some six metres *below* the adjacent plain level. Drawing irrigation water from this deep bed requires water-lifting technology, evidence for which first appears in the latter 1st millennium BCE (when the Tigris was located in or near its modern course). Because of its presumed location (that is, distant from early cities and their agricultural hinterlands in the central alluvium) and these challenges to its use, earlier scholars posited an ancient and long-lasting agricultural irrigation system that relied primarily on the Euphrates, rather than the Tigris — a view shaped by river forms in the central (at the time, desert) strip, where archaeology was actively conducted, rather than in the reaches east of the Shatt Al-Gharraf, where (even then) the Tigris splayed into multiple (actively farmed) beds and floodplains.

Modern state projects: engineering and agronomy

Today, the entirety of this riverine world is characterised by gridded and cross-cutting irrigation and drainage canals that span the breadth of the alluvial land between the rivers. These divide the landscape into irrigated fields ranging from laser-levelled, identical squares to largely irregular plots following an older, more organic organisational logic. These massive hydrological works are the culmination of a century of intentional re-engineering of the river system, in an attempt to return the central plains to agricultural productivity and maximise economic outputs on state-controlled land. The modern architects behind these initiatives saw the visible remains of ancient levees as evidence of the dynamic movements of the rivers, and of past human actions to control and direct the flow of water. They understood their own efforts as means to progressively 'reclaim' fertile lands that once fed now-dead empires, and as a continuation of past engineering efforts that characterised (and were fundamental to) the development of society in Mesopotamia.

To this end, modern hydrological engineering of the system began in earnest in 1910, with British civil engineer Sir William Willcocks. Based on multiple contracts in Egypt, culminating with completion of the first (low) Aswan dam in 1902, Willcocks was commissioned by the Ottoman government to develop plans to restore and enhance ancient irrigation works in Iraq (Ozden 2013). His interest in the area was rooted in his religion and interpretation of the Bible, which stressed the importance of water from the twin rivers in creating life and maintaining the biblical Garden of Eden, identified as lying somewhere in the lowland marshes of Southern Iraq (Willcocks 1912: 131). With a team of engineers, he conducted field surveys — taking stream discharge measurements, collecting samples of soil and water, and consulting with local inhabitants. From this work, he produced maps of the hydrology, geology and topography of the area; project recommendations for the location of dams; and estimates of reclamation potential. He then directed construction of a control barrage at Hindiya, ultimately bringing an additional 3.5 million acres of land around Babylon under cultivation.

The overarching conclusions and exemplars of his work in the upper alluvium: namely that land could be reclaimed or 'restored,' irrigation works revitalised, and tenure practices reformed, influenced both subsequent historical reconstructions of the role of irrigation agriculture in the development of earlier state-level societies, and government sponsored, large-scale agronomic reforms and projects over the following decades. The success of this early hydro-engineering spurred further large-scale landscape transformation activities from the 1950s through the turn of the millennium.

The Musayyib land reclamation project exemplifies crown-sponsored agronomic reforms taking place from the mid-20th century, and illustrates the increasing scale of landscape engineering required to re-cultivate long-abandoned agricultural zones. A section of the alluvial plains southwest of Baghdad was chosen for a large-scale irrigation project that aimed to bring salinised fields back into cultivation. Engineers and surveyors portioned out rectangular units of roughly equal (circa 2 ha) size, and laid out intake and drainage canals from the Tigris to water them (some of which re-used archaic canal beds) (Figure 16.2). This project successfully brought millions of acres under cultivation by moving new groups of people into the area, reshaping land tenure relationships, and displacing pastoral access to now intensively cultivated tracts. The high mounds of tells' central precincts — preserved at field corners to serve as boundary markers — survived this wholesale reconfiguration. But, except in specific cases where the beds of ancient waterways and irrigation channels could be re-adapted to serve these new systems, site suburbs and intervening landscapes (including smaller sites and features) were not — irrevocably skewing results of later surface surveys.

As in antiquity, in that arid climate, given the high water table and evaporation rates, drainage canals were essential to the project. Without them, capillary action wicked gypsum and salts dissolved in groundwater upward into the root zone, resulting in rapid salinisation of agricultural soils. First planned in 1951, from 1991–1994 these and other drains were consolidated into the so-called al-Qadissiya River, Third (Saddam) River, Umm al Ma'arik (Mother of All Battles, or MOB) River, and main outfall drain (MOD), which bypassed the southeastern marshes and shunted polluted, saline agricultural return water from the northern alluvium directly into the Gulf via a shipping canal completed in 1972 (Basra River) (FAO 2015; Merry 1992) (Figure 16.1).

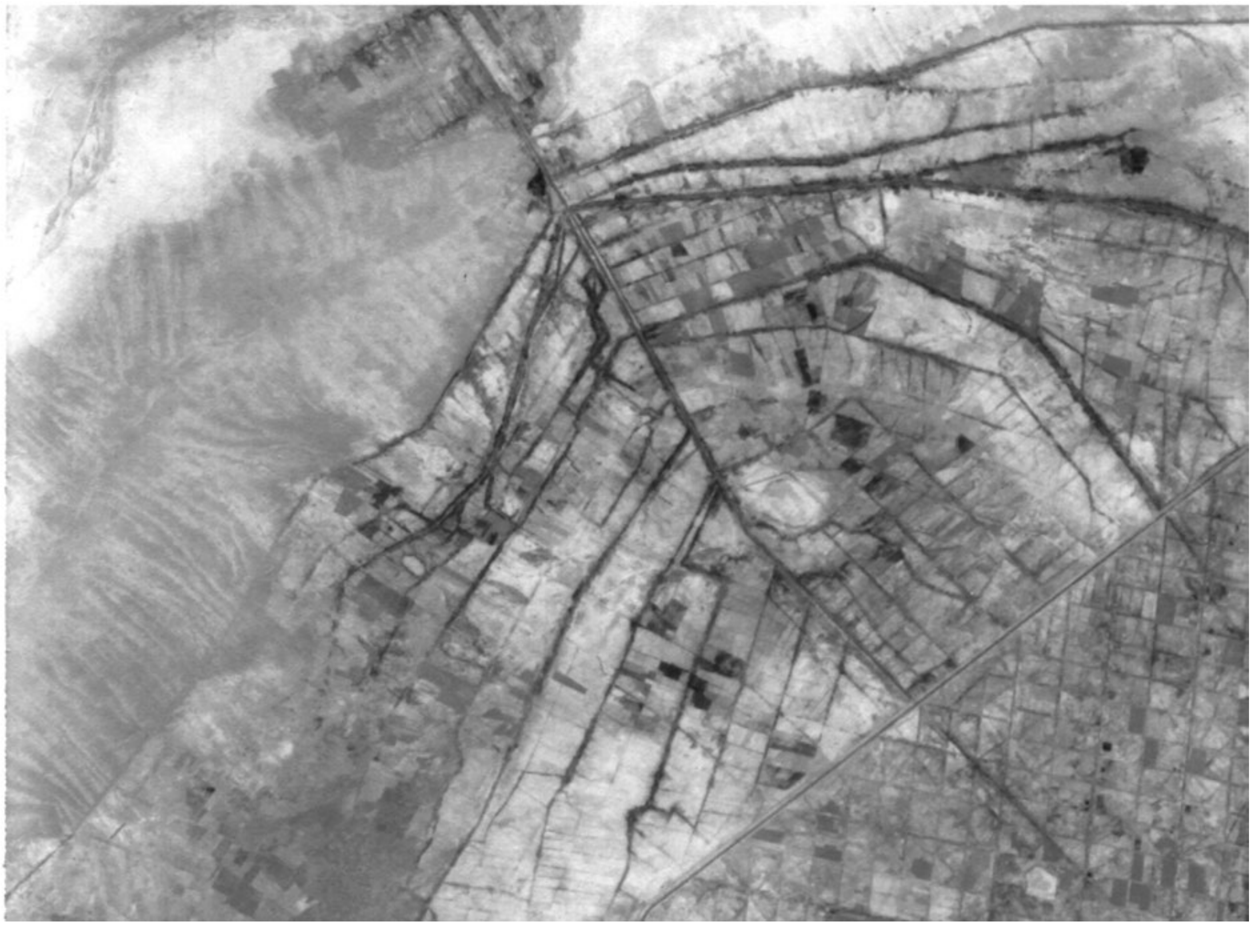

Figure 16.2. Intensive cultivation on the Upper Mesopotamian alluvium. The gravity-fed herringbone-patterned irrigation system (top left) carried water down Tigris levee banks during the time of the Third Dynasty of Ur (2nd millennium BCE). As deposited sediments reduced gravity flow, the irrigation system was abandoned, then re-engineered by early 1st millennium CE Sasanian engineers (center). Head works maintained water levels from multiple intakes, allowing re-use of some older canals. Modern field systems are machine-levelled (right bottom); water flow requires downstream dams and electrical pumps. Without adequate drainage, intensive irrigation results in soil salinisation; abandonment of such systems leaves silts vulnerable to wind erosion. Image: CORONA 1968.

Downstream, the Kut barrage was implemented 1934–1943, also to direct irrigation water from the Tigris River to surrounding agricultural fields (Cressey 1958). Its regulator maintained sufficiently high Tigris water level to rejuvenate the silt-clogged Shatt al-Gharraf (Gharraf River), a major south-flowing distributary that had long since dwindled to a fraction of its former flow. In 1952, the Dujala land reform project launched, intended to expand irrigable land along the Gharraf, revise land tenure, and bring additional 26,425 ha under cultivation. To shift economic power from absentee landlords to local producers, farmers were given 25 ha each and required to live on their plots. The barrage also supported a road and lock, interconnecting navigable shallow-draft shipping between the Tigris and Gharraf (Fisk 1952; Kliot 1994: 117–120).

Although originally designed to prevent saline return water from entering the Euphrates and damaging downstream croplands, completion of the Third River also resulted in *de facto* diversion of two-thirds of the water that formerly recharged the southern marshes. The combined effects of return water starvation, increased irrigation withdrawals, and flow reduction by upstream damming forced relocation of many inhabitants, and did not result, even upon its delayed completion, in creating new agricultural land. Instead, marsh areas were rapidly salinised, and agricultural production there declined (Adriansen 2004). Following the 1991 Gulf War, this unintended consequence served as a grim model for an intentional one. In retribution for Southern Iraqi support for the U.S.-led multi-national military coalition, Saddam ordered immediate implementation of another set of 1950s plans, originally intended to extend agricultural expansion and desalinisation eastward, but shelved as disastrously unworkable due to the high, salty water table. Quickly altered, these went forward as a deliberate marsh destruction programme. Save for a small remnant of the Hawiza marshes on the Iranian border in Maysan Governorate, the entirety of the remaining permanent marsh area — some 20 km^2 — was systematically poldered, its waters funnelled into the main outfall drain system and the kilometre-wide, purpose-built Nahr al Azzaz ('Glory River'), thence via the Shatt al Arab and Basra River directly into the Gulf (Partow 2004).

Over the course of one century, these projects demonstrated all of the key characteristics of the Lower Mesopotamian river system: (1) the tendency of the rivers to move channels over significant distances; (2) the cumulative problems of water table height and salinity for productive, irrigated agriculture; (3) a landscape inheritance that increasingly requires human engineering in order to sustain a fixed-place irrigated agricultural economy; (4) the political use of water (for good and ill); and (5) the impossibility of making any physical reconstruction of past river systems without including their human component — interactive as those rivers were with the inhabitants of the alluvial plains.

Mapping canals and rivers

The 20th century infatuation with massive irrigation projects coloured scholarly concerns for decades, resulting in a body of work on the history of irrigation systems and related technologies, as well as heated debate regarding the role (or lack thereof) of previous state and imperial aspirations in those systems' expansion and collapse. In landscape terms, this intellectual impetus was reflected in attempts to map (in part or comprehensively) the river systems as they existed in various periods, or to reconstruct their likely paths based on association with visible archaeological remains and hints from historical texts (such as toponyms listed in trade itineraries). From the mid-20th century on, connecting the fluvial dynamics of the rivers to the growth and expansion of settlements and society in Southern Mesopotamia has been approached from a combination of historical, archaeological, and ethnographic approaches at multiple scales.

Unfortunately, many of these efforts — like the state-sponsored irrigation engineering projects themselves — suffered from three crucial disconnects. The first was ignorance (at any given point in time) of the overarching dynamics of living river systems. The rivers came to be 'defined' by discharge rates and particular flood events; by technologies required to engineer and manage irrigation systems serving state bureaucracies — not by the essential ecological interactions of all components of their watersheds. That their floodplains and deltas were immensely bioproductive sponges, intimately bound with water sequestration and microclimate levelling, was quite literally beyond the horizons of those working in the central desertified strip.

This led to the second: projection of various 'northern' views onto the entirety of the alluvium. At no time were the rain-watered plains of the Assyrian uplands representative of Akkad, where emerging rivers dumped their massive sediment loads. Nor were the meandering and anastomosing levees in the heart of Akkadian central plains ever representative of the interlocking splays, fresh marshes, and inner deltas of Sumer — let alone the lakes, lagoons, estuaries, and salt marshes between Sumer and Elam, later known as 'the Sealands.' Several studies do recognise this, linking local landscape variability (and the complexity of processes that transform it) to field tenure systems, as means for aggregating political power and altering social organisation (e.g. Liverani 1997 and Steinkeller 2007; Widell 2014). For example, both Widell's re-analysis of Ur III texts (Widell 2013) and Liverani's discussion of the differences in field size and layout between the northern and southern alluvial plains, draw attention to the role of topography in shaping and maintaining social relationships and administrative centralisation. Liverani (1996) specifically connects differences in long term social organisation between the areas of 'Akkad' and 'Sumer' to different field patterns, organised around fundamental differences in the riparian landscapes they inhabit.

The related third disconnect is temporal, rather than spatial. Although Adams's and other's works do clearly argue for changes in the river system as a primary driver of changes in social, political and economic systems through time, *other than major shifts in channel beds*, they assume both uniformity and stasis of the river regimes — allowing for the interpretation that (especially 2nd millennium BCE) Akkadian hydrological landscapes represent other time periods within the same space, and/or other places along the alluvium. But, as seen at sites like the northern Tell Abu Salabikh discussed below, not only is that 2nd millennium Akkadian landscape, as imagined and reconstructed from 2nd millennium BCE accounting texts, unrepresentative of Sumer: it is not even representative of its own earlier selves.

So, in light of archaeological, historical, ethnographic, and biophysical evidence accrued over the past two decades, static approaches — black lines on white maps, plus assumptions that naming conventions are consistent along the course of any given waterway — are simply no longer tenable. Discrete components of Southern Mesopotamian river systems underwent nested cycles of change, driven by both human and natural processes, at global, regional, and local scales. In that context, it is a misconception to assume that the fundamental riparian regimes of any given location or time period can be applied wholesale to the entire alluvium, or projected backward in time for a given location. These highly variable riverine processes are indeed highly meaningful — but are understandable only in their movement *through* space and time.

Archaeology and landscape

Archaeologically, aside from the layered remnants of relict and re-used canals and channels, mounded sites ('tells') are the truly outstanding features marking the modern landscape. These comprise the accumulated material remains of long-term occupation, and number in the many thousands. In addition to the approximately 2800 plotted by Adams, Gibson, and Wright, Hritz mapped an additional 3400 — ranging in size from hamlets covering barely one-tenth of a hectare, to the ruins of great cities stretching a mile in diametre — with nearly a quarter of the delta still unsurveyed from ground or air (Adams 1981; Algaze 2008; Gibson 1972; Hritz 2010; Stone 2008; Ur 2013). Add to these perhaps one-third of the 6692 recorded on Iraq Department of Antiquities site registers that fall outside the surveyed zones, hundreds more extracted from Department of Military Survey topographical maps, and 1200 subsequently recorded in the former marshland, and 15,000 may be a conservative estimate (Hamdani 2015).

On the one hand, the sheer preponderance of tells reflects the importance of fixed place in the long history of Southern Mesopotamia. On the other, their mapping reinforced the preconception that, if not all population, then the majority thereof, resided in these mudbrick-walled nuclear sites. Uncounted, tent-resident, mobile pastoralists navigating unwatered wastes were presumed to be the only other settlement form. Marshes and 'backswamps' might have been 'exploited' by or used as 'refuges' from tell-centred states, but since they could not be reached by motor vehicles, that they might have boasted their own, population-dense, but archaeologically less visible forms of water-associated residence (urban or rural) was never investigated.

The first attempts to associate tells with relict water courses were made during the Diyala Basin Archaeological Project, begun in 1937 and led by Assyriologist Thorkild Jacobsen of the Oriental Institute at the University of Chicago (Jacobsen 1960: 174). The methodology developed for the project was further refined by subsequent scholars over the course of numerous surveys on the alluvial plains (Adams 1957; 1981; Gibson 1972; Wilkinson 1990; 1981). Their premise — and the premise that has guided Mesopotamian studies since — was that durable human settlement in ancient Mesopotamia was *only* possible along river channels and canals, and thus was spatially constrained. They postulated that by systematically mapping all mounded sites in the region, dating them by examining pottery visible on the surface (Ceramic Surface Survey), and plotting them on periodised maps, any 'linear' patterns that emerged would represent the major routes of ancient watercourses (Jacobsen 1960: 174). Thus, the spatial distribution of tells was used to infer the location of channels and canals that were no longer (or only partially) visible on the ground, and for which there was no actual recorded evidence.

Proceeding from this premise, Jacobsen and Adams (1957; 1958) presented an initial outline of the riverine system that underpinned their narrative of broader Mesopotamian history (Figure 16.3). In summary, they argued that by late 5th millennium BCE, branching and splitting from somewhere north east of Tell ed-Der, the Euphrates flowed through three major channels southeastward toward the Gulf. The first ran down the western alluvium from the ancient city of Sippar to Kish, and thence onward to Marad. The second also began at Sippar, ran to Kutha, and continued via Jemdet Nasr to Nippur, anastomosing and rejoining along its route. The third, easternmost branch proceeded from Tell ed-Der, passed to the east of Jemdat Nasr, and thence toward Adab. This reconstruction left little room for the Tigris River to run on the alluvial plains. To account for its absence, Jacobsen proposed that for much of antiquity the Tigris was located to the northeast of its current bed, in the Diyala River basin. Changes in river channel locations were attributed either to fluvial dynamics or to the outcome of human interventions.

From this effort, a model of the settlement system emerged in which sites and channels were inextricably linked. Embedded in that model was the presumption that 'linear' alignments always demarcated canals. While, indeed, in many cases their banks and beds were undeniably visible; where they were not, other explanations (such as 'connect-the-dots' selection bias or geophysical processes leading to selective site exposure) were not considered.

Beginning in the late 1950s — notably, well before geological investigation of and consensus on plate tectonics — and continuing until the late 1980s, Robert McC. Adams elaborated the most spatially extensive and empirically integrative sketch of this settlement system. He surveyed much of Southern Iraq between Baghdad and the westernmost extent of the agricultural zones along the Shatt Al-Gharraf (Adams 1957; 1958; 1965; 1972; 1976; 1981).

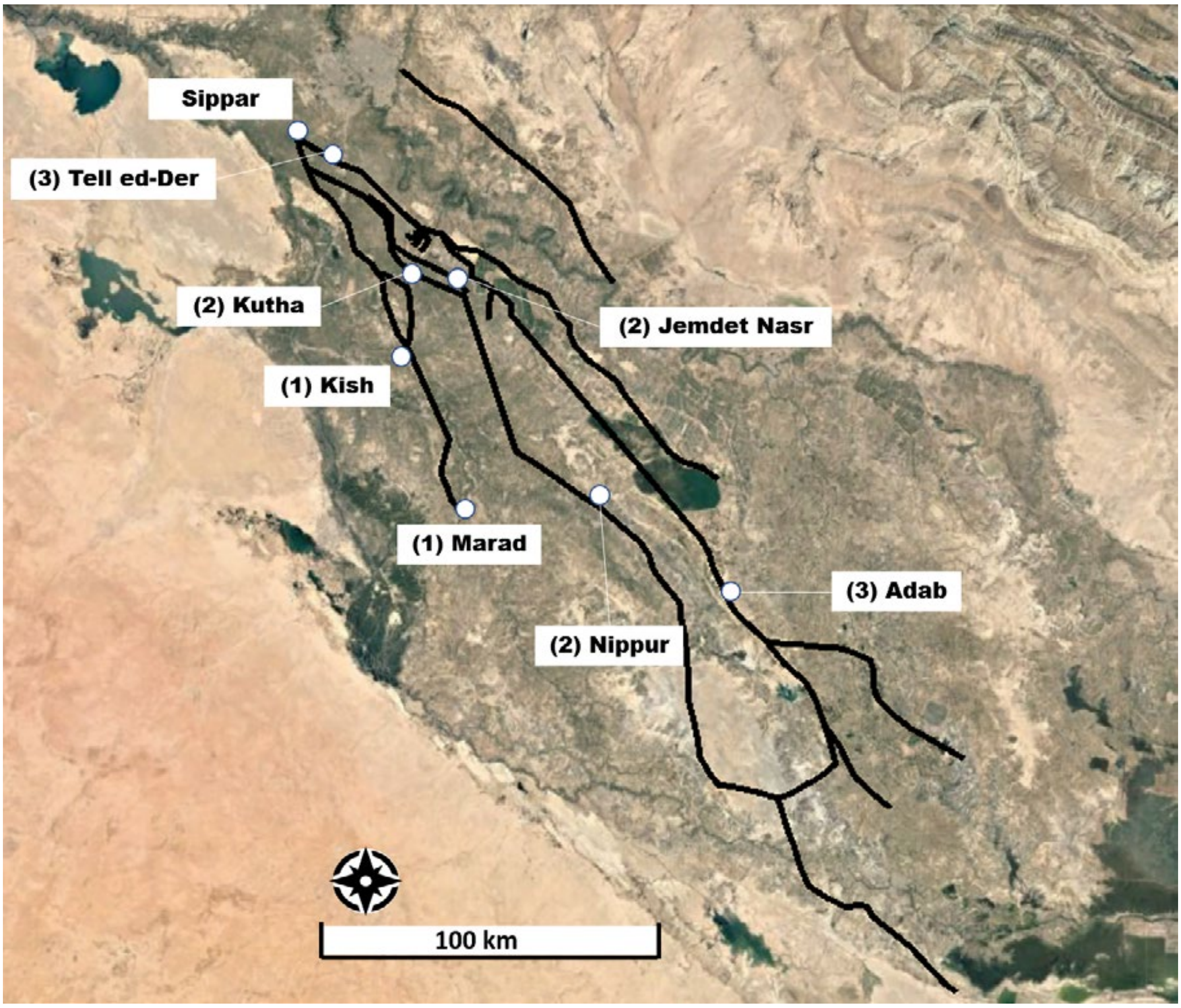

Figure 16.3. Black lines on white maps: The Tigris and Euphrates Rivers, 5th–3rd millennium BCE, according to Adams (1957; 1958) and Jacobsen (1960). Adams posited three major channels running from (1) Sippar to Kish, and thence Marad; (2) Sippar to Kutha, via Jemdet Nasr on to Nippur, anastomosing and rejoining along its route; (3) Tell ed-Der, east of Jemdat Nasr, thence toward Adab. He later argued that at the onset of the 4th millennium BCE, flooding caused the early Holocene joint Tigris-Euphrates River to split into separate flow regimes. A second major transition occurred during the early half of the 2nd millennium BCE, when an abrupt shift consolidated the bulk of flow into western branches. Jacobsen placed the Tigris east of its current bed, rendering it "unavailable" to cities of the central alluvium.

Developing the spatial, theoretical, and methodological approaches of his early work with Jacobsen, Adams identified possible archaeological sites on British Ordnance Survey maps and aerial photographs. He then drove to each, navigating by dead reckoning; triangulated their positions with a Brunton compass; noted their locations; then collected ceramic material from their surfaces in order to anchor them chronologically. The surveys covered an expansive area, aimed to generalise historical trends, and integrated archaeological and cartographic evidence with the aid of aerial photography (Adams 1981; Pournelle 2007).

Text and context

Jacobsen fleshed out his basic outline by correlating the surveyed tells and relict levees with (cuneiform) textual references to river channels and place names, focusing in particular on those enduring channels of the Euphrates River that over millennia fed the city of Ur and its environs. This work suggested that the northern part of the alluvial plains were watered by a few large effluents of the Euphrates. Once these branches passed Nippur and Adab, they split and rejoined as they made their way toward their delta somewhere in the great southern marshes. Conflating textual (cuneiform) sources from several sites in northern Akkad dating to the 3rd and 2nd millennia BCE, Jacobsen implied an underlying stability to the channel system, despite several evident changes in flow documented by long use of some names over what could only have been different routes, as indicated by the names of cities they joined (Adams 1981; Gibson 1972).

Exploring his survey data in light of geological data gathered by Belgian archaeologists working around the twin sites of Sippar and Tell ed-Der, near Baghdad (Paepe 1971; Paepe and Baeteman 1978), Adams further hypothesised the rivers' dynamics. Enhancing Jacobsen's overall framework, he plotted two major transitions in the overall river system, the first at the onset of the 4th millennium BCE. Adams argued that at this time, cumulative Euphrates channel flooding caused an Early Holocene massive joint Tigris-Euphrates river to split into two, creating an eastern channel running along the edge of Lake Dalmaj (the Tigris), and a western channel following lower elevation (the Euphrates). In his view, the cumulative effects of Euphrates flooding and sedimentation pushed the Tigris to the east, and thus after the 4th millennium BCE minimised its influence on human settlement and development of irrigation agriculture (Figure 16.3).

In this model, over the succeeding millennia, several anastomosing and leveed branches of the Euphrates dominated the landscape. Adams suggested that during these formative periods, control of Euphrates channels and their tributaries was essential to economic and political stability, enabling long distance trade, boat travel for people, animals and goods, and extensive irrigation agriculture. But by the 3rd millennium BCE, widespread human modifications of the naturally branching channels and canals were required to maintain a stable irrigation system and meet the needs of the growing cities and their populations.

The primary difference between Adams's and Jacobsen's reconstructions of the riparian system in these formative periods is their respective conclusions regarding a series of large, relict river meanders running down the central alluvium, signs of which are still evident today. While Jacobsen identified these as relics of the easternmost branch of the Euphrates, with the Tigris located either yet further east or in its current location, Adams concluded that this was in fact the historical course of the Tigris. He plotted two large, relict Euphrates courses in the western portion of the alluvial plain, with the Tigris following meander scrolls still visible in the area of Lake Dalmaj (Figure 16.4).

This reconstruction was subsequently explored from cuneiform textual sources in a series of publications by Piotr Steinkeller (2001; 2007). Steinkeller correlated tells identified by Adams with cities and towns mentioned in 3rd millennium BCE texts, in the context of their relationship to water courses named 'Tigris' and 'Euphrates' as they were then known. That the tells and water courses both featured in trade itineraries was never in doubt, but whether names for the Tigris were consistently applied only to a waterway with its headwater tributaries in the Zagros, or to any waterway (whatever its source) flowing in that bed, was less clear.

The historical implications of Adams's reconstruction were twofold. Firstly, assuming a single, below-plain bed, if the Tigris ran close to some of the long-standing, large urban centres of Mesopotamia, this suggested that political and technological capacity, namely water lifting devices, to surmount the challenges posed to management if its monstrous water supply was developed far earlier than previously thought. Secondly, changes to the morphology of the river indicated by those massive meander scars at its southern end suggested that it debouched into a large body of water (lake, marsh, lagoon, or embayment) near the modern day Shatt al-Gharraf — some 300 km northwestward of the present-day Gulf head.

Adams argued that a second major transition to the system occurred either at the end of the Isin-Larsa Period or the beginning of the Old Babylonian Period (early-half of the 2nd millennium BCE). At this time, an abrupt shift in flow occurred within the main branches of the Euphrates, consolidating some of them. Concurrently, there was channel consolidation of the Euphrates branches. The bulk of the water volume shifted to far western branches, changing the pattern of flow from almost north–south to northeast–southwest. Adams proposed that the impact of these changes on the one hand enabled Babylon's growth into a major centre in this period, and on the other led to the decline of cities such as Nippur in the centre of the plain, which witnessed a period of abandonment due to a lack of water. Over time, Adams plotted an increase in artificial canals that sought to cut across the topography of the plain and bring water back to the dewatered cities, and argued that this reflected a fundamental shift in the human-channel relationship. Adams argued that, prior to the 2nd millennium, even with artificial irrigation, settlements were tied to the rivers themselves, and occupants had to move if a channel shifted. In the 2nd millennium, despite drastic changes in channel path, the evolving technology of engineering canals meant that settlements could remain and water could be directed back to them in a much more complex manner. Both conclusions of course relied on a presumption that channel switching — diversion of a river from one bed to another, changing the black line on the white map— was the only riparian transformation across space or through time, and riverbank settlements were the only settlements.

Mesopotamian rivers and mesopotamian civilisation

The theoretical constructs outlined above formed the basis for models of the rise and collapse of Mesopotamian society. In Adams view, 'human agencies do not merely supplement but in part transform some

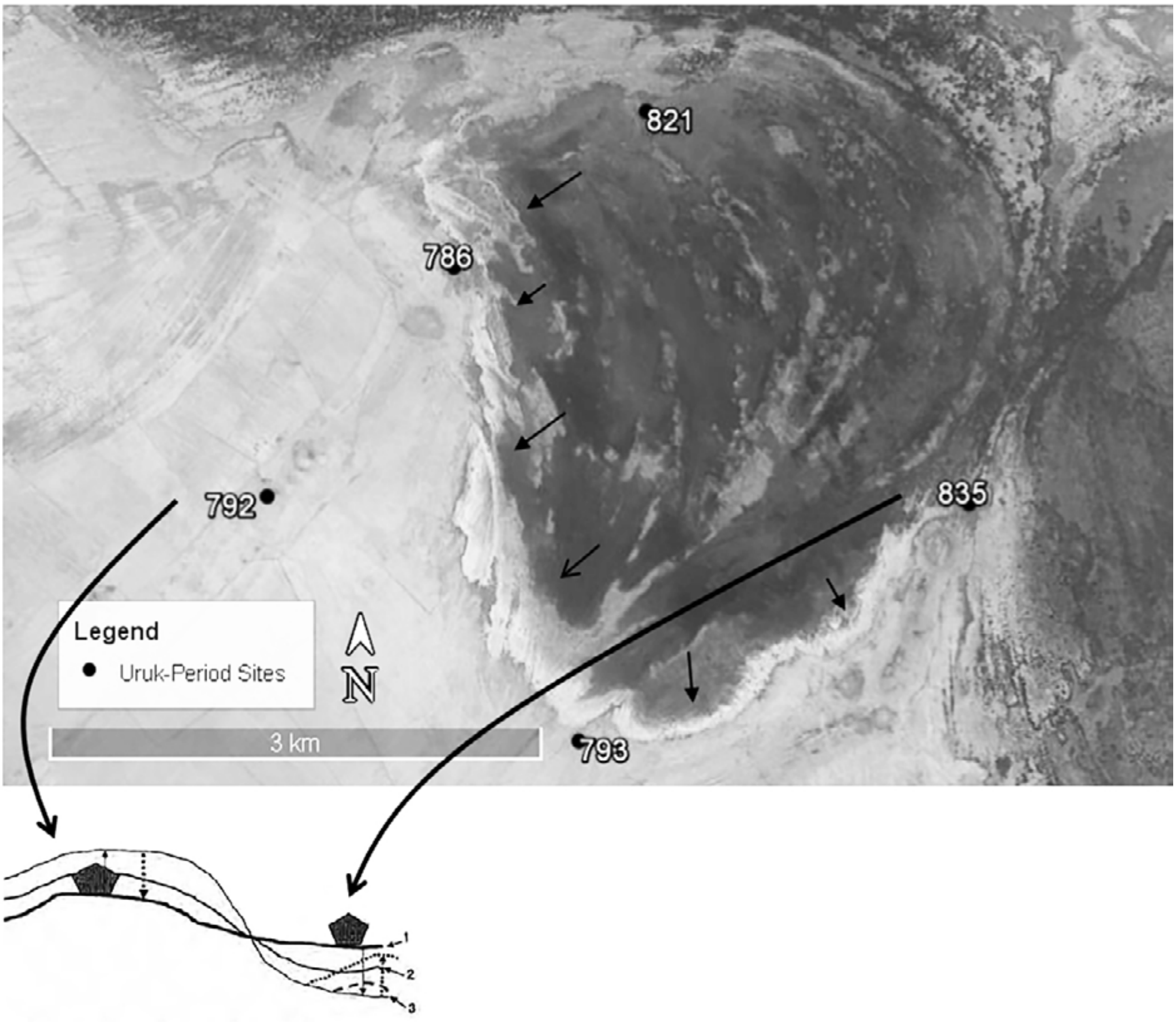

Figure 16. 4. A meander scroll northeast of Nippur. Re-introduction of irrigation into long-abandoned field systems increased subsoil moisture and stabilised windblown silts. Small arrows show limits of wind scouring to a salinised surface. Benefits were short-lived: by 2011 the “reclaimed” fields were already abandoned, and Lake Dalmaj, formed from irrigation return water, was evaporating once again. The Uruk–Jemdet Nasr sites (numbers refer to the Adams 1981 Nippur Survey) are more correctly associated with the overlying soils than with the scroll itself. Multi-period (re-occupied) sites like 821 and 835 are pedestalled above the deflated plain surface and have lost their contemporary landscape context. Single-period sites like 792 are partially buried, their tops exposed by the scouring winds. The meander scroll itself is therefore not contemporaneous with any of these sites: it is considerably older. Digital Globe 2011, courtesy Google Earth Pro. Inset: after Wilkinson 2003: fig. 5.5.

of the dominant forces and forms of even the physical landscape (1981: 19)’. Physical activities such as the damming, diking and straightening of waterways and canals would have served the dual purpose of directing and managing water for agriculture, and facilitating boat transportation along the rivers. At the same time, these engineering activities resulted in increasing capital investment in places and fields, such as at Nippur, Umma and Adab, and generated enduring social institutions, such as land tenure systems and practices of water access and exploitation.

Adams emphasised the centrality of irrigation agriculture to Mesopotamian societies, but argued against a Wittfogelian view of the role of irrigation in the rise of complex societies (Wittfogel 1957). Rather, he described a more nuanced dynamic between transformations in socio-economics and technological innovation. He saw the potential in understanding long-term cycles of change in settlement pattern and land use practices reflected in the complex relationship between settlement locations, river courses, and irrigation channels. He argued that these features — tells, relict channel levees, and canals — formed the visible cultural landscape of Southern Mesopotamia. In a pivotal 1958 article in *Science*, Jacobsen and Adams described the importance of balancing transformative activities such as expanding and extending irrigation systems, against negative consequences such as episodes of salinisation, increasing reliance on interdependent economies, and vulnerability to systemic disruption (whether natural or political). They linked the cycles of political consolidation and collapse in Mesopotamian history to transformations of the river system, with large urban cities forming when fewer channels were available, followed by demographic collapse when the maintenance of the irrigation system was neglected.

While Adams's work presented the overall picture of the riverine system and its relationship to ancient settlement distributions, he recognised that the scale of his surveys and the intent to cover as much ground as possible during the time permitted would result in the loss of local detail. He himself, in the foundational work *The Heartland of Cities: Surveys of Ancient Settlement and Land Use on the Central Floodplain of the Euphrates* (1981), outlined some of the limitations of his survey and analysis, illustrated by a detailed resurvey of a small area (Adams 1981: 40–51). One of those limitations was the fragmented availability of topographic maps, which are difficult to acquire for Iraq. Despite geological surveys throughout the 1950s, 1960s and 1970s, most of the maps produced were not preserved. Those that were available provided only piecemeal coverage, making their use difficult for investigating the entirely of the fluvial system.

However, beginning in 1976, under the leadership of Hermann Gasche, a team from the University of Ghent acquired 1:20,000-scale topographic maps and aerial photographs for a 400,000 ha area southwest of Baghdad, in order to explore the local topography and present a detailed reconstruction of the river system in light of further textual evidence. This proved a useful means to test the accuracy of channel reconstructions based on the presumptive linear relationship of sites. Gasche mapped all visible geomorphological features, including relict river meanders and abandoned irrigation works, as well as tells. For the next 15 years, the team examined features on the ground. They identified traces of levees, described the process of levee formation, and produced an outline of the local river system. Working with Assyriologist Steven Cole, they contextualised that system with chronological and historical markers tied to evidence excavated at Tell ed-Der. Their work suggested the appearance of evidence for flood mitigation in the first-half of the 2nd millennium BCE (Cole and Gasche 1998: 10).

Importantly, the Ghent team demonstrated that sensitive appreciation for local geomorphology could not be ignored. Underlying physical processes in the alluvial plains guided channels, and previous inattention to actual topography had resulted in others 'mapping' impossible canals that, to connect presumed linear alignments of sites, would have had to flow uphill over substantial, older levees. Their reconstruction showed the complexity of channel systems both temporally and spatially, and revealed that the three dominant branches 'mapped' by others told only part of a larger story.

With a detailed example from the time of Hammurabi (mid-2nd millennium BCE), the team also showed how due attention to physical geomorphology was essential to reconciling apparently conflicting textual information about channels and environment. Letters between Hammurabi and his contemporaries in Northern Iraq and Syria (Zimrilim) describe high floods and widespread efforts to contain the Euphrates. Yet, textual and archaeological evidence from their contemporaries in Southern Iraq indicated that water level in channels was so low that they required active investments in dredging. Palaeoclimatic data indicate that this was in fact a period of relatively low precipitation and flow levels (Cole and Gasche 1998: 11). The explanation for this apparent contradiction was that 'low water in a river leads to the siltation of its bed and the constriction of its channel. When this happens, the river can no longer flow with enough force to scour its bed until the arrival of the annual spring runoff, when the combination of a filled-up bed and a sudden increase in water volume can spell disaster' (Cole and Gasche 1998: 11). These examples illustrate the interlinked relationship between human actions and natural changes in the riverine system, and that disentangling the remains of the ancient landscape was not straightforward.

The cumulative contribution of these efforts to map the Mesopotamian watershed through time has been to demonstrate that any model of the major social and political changes in Mesopotamian history implicitly requires understanding of the complex processes of sedimentation, erosion, and channel dynamics over space and time. As we will see in subsequent sections, Tony Wilkinson and his students have made signal contributions in this regard.

Landscape and adaptive limits

The turn of the 21st millennium ushered in a new period of study of the complex relationship between humans and their environment. For the first time, innovations in approach, methods and technology enabled multi-scalar exploration of the Mesopotamian landscape and the analysis of its river system as a geographic whole. A leader in this initiative, Tony Wilkinson described the importance of such synthetic analyses:

> Many fundamental works on the origins of states (Wright 1994; Adams 1981) necessarily build upon landscape data, but the overall study of the Near

> Eastern landscape itself has not been laid out either empirically or theoretically. Moreover, the underpinnings of the state as manifest in exchange systems, 'world systems', and alternative models (Stein 2000) are traditionally predicated upon the political economy and its social underpinnings, but these too implicitly require an understanding of the structure and distribution of settlement and landscape. The lack of systematic study of the Near Eastern landscape has, I believe, impeded the development of archaeological research (Wilkinson 2003: 3).

Wilkinson's work both made explicit and tested the underlying assumptions of the role of the physical landscape in ancient Mesopotamian societies. His cumulative work in Turkey, Syria, Iraq, Iran, Oman, and Yemen resulted in a framework that describes the attributes of the ancient cultural landscape and its development over time in a dynamic environment (Wilkinson 2003). He sought to understand principles that underlie the selective attrition and preservation of features, such as the dynamics of erosion and redeposition, landscape degradation, and how soils and water were managed through time. He advocated a holistic spatial and landscape perspective that moved beyond mound survey, sought to identify signature landscape features, and from their spatial relationships inferred broader qualitative shifts in settlement and population that reflected changing political, socio-economic and environmental conditions over time. The landscape was no longer the *context* for civilisation, but an active *player* in shaping and constraining human activity, as well as a repository for evidence of that activity that could be generalised to understand broader social questions.

The problem of continuous landscape

Methodologically, Wilkinson introduced systematic geoarchaeological collection theretofore common in the United Kingdom and elsewhere in Europe, but woefully lacking in most Middle Eastern practice. His contributions included ground augering and coring, geomorphological and sedimentary analyses, and compilation of maps into geographic information systems. In his book *Archaeological Landscapes of the Near East* (2003), he outlined methodology for conducting systematic landscape investigation in arid regions that established a new, higher standard for landscape and archaeological survey in Mesopotamia. It includes: (1) examination of maps, aerial photographs and satellite images; (2) spatial analysis of landscape features; (3) field verification and data recovery; and (4) analysis of geoarchaeological samples.

On the ground, his work initially focused on systematic off-site survey around the massive tells charted in previous studies. From just two small-scale endeavors, the first conducted in Southern Mesopotamia, Wilkinson demonstrated empirically that space between tells contained important material remains that, when systematically collected, shed light on crucial structural changes. These included evidence for processes of urbanisation and settlement dispersal, long-term demographic trends, reconstruction of land use systems, and recognition of trace evidence of transitory settlement (Wilkinson 1995; 2000; 1989; 2003; 1982).

Specifically, he identified *signature features*, consisting of contemporary features that reflect a broad range of human activities such as tracks, fields, canals, agricultural installations, persistent places, and religious foci that, through use and re-use, remain etched into the landscape over time (Wilkinson 2003: 33). Such features are subject to transformations that, through repeated survival and destruction, leave them partially or wholly preserved among landscape layers. When dated by relative or absolute methods, those features most deeply etched into the landscape provide windows into landscape evolution.

Wilkinson's surveys in Southern Mesopotamia applied these concepts. He identified the phenomenon of 'continuous landscape' as a particular challenge for understanding settlement trajectories in Southern Mesopotamia (Wilkinson 2003: 36). In the alluvial agricultural landscape, a near continuous blanket of cultural features, including earthen ridges upcast from canal excavation and dredging; extensive scatters of sherds, industrial waste, construction materials, and other artifacts; roads, field boundaries, and remnant irrigation systems fill the spaces between tell mounds, and often cloud the visibility of individual features and spatial boundaries. He attributes this condition to a combination of continuous human activity, including both ancient and modern plowing, and the complex riparian dynamics of the powerful Euphrates-Tigris River system. He states succinctly 'What is less well understood is that the alluvial lowlands of Southern Iraq have undergone extraordinarily complex processes of aggradation and deflation as a result of the interplay of both human and natural processes. As a result, *early sites in some areas are buried whereas other within a few kilometers can be pedestalled above the existing plain level*' (Wilkinson 2000: 229, emphasis added).

Wilkinson demonstrated this situation with his surveys around the mounds of Abu Salabikh[3] and Mashkan-

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[3] 'Abu Salabikh' is translated from Arabic as 'Place of Pebbles.' It is a common name for tells — covered, as they are, with rubble of past ages. Archaeologically, two are of note. The one here referenced lies in

Shapir (Figure 16.4: Inset). At Abu Salabikh, he employed a combination of systematic surface ceramic survey, off-site survey between mounds, and transect auguring, and identified ten additional archaeological sites within a 12 km radius of the mounds. Three of those sites, dating to the 3rd and 4th millennia BCE, were completely buried *below* the alluvium, alongside traces of ancient water channels. Significantly, both the sites and the channels were unapparent at the surface, detected only during inspection of a section cut deep into through earth during construction of the Third River (Wilkinson 1990). More significantly, he showed that the river regime itself had utterly transformed through time. At the site's founding, 'the' river was neither incised nor banked: it did not weave around sites in a meandering channel, rather interpenetrated among them in a marshy splay. There *was no* 'early' channel whence the mighty Ur III levees descended. Rather, over the course of the intermediary millennia, episodes of sedimentation, deflation, and redeposition of silt had deeply buried the site, as they transformed what had then been a marshy wetland into an arable fluvial *bund*.

Conversely, Wilkinson showed that in the plains around Mashkan-Shapir, wind scour and deflation of the light, easily transported, silty soils had left features pedestalled *above* the contemporary landscape (Wilkinson 2004: 402–415). Following micromorophological and geochemical investigation, he concluded that, throughout these areas, the most visible traces of relict canals and the highest sherd densities were consistently located in previously irrigated (and repeatedly plowed) areas — that is, those most susceptible to wind deflation (Wilkinson 1982; 2003). Further, not only did sherd densities tend to decline consistently further away from the mounded areas; sherds became progressively more battered and worn in appearance, sherd typology (relative chronology and function) became more heterogeneous, and sherds were less consistently associated with other indicators of habitation or industrial activities.

Wilkinson interpreted these scatters to be the product of topsoil deflation in ancient agricultural zones, representing the accumulated evidence of past manuring of fields with household and midden waste. Their presence thus indicated the accumulated *loss* of more recent landscape features, blown away over time by relentless summer winds. Therefore, their mere co-location with any specific landscape feature could *not* be used as a chronological proxy for dating the feature itself, since they might have been transported from a midden to fertilise the field at any time up to the present, and/or they might be visible at the surface only because the surface upon which they originally lay had been scoured away entirely. Wilkinson's methodology and conclusions had immediate implications for previous attempts at mapping past instantiations of the Tigris-Euphrates river system, as well as for any association of sites to canals or waterways. 'Sites' (particularly tells) in and of themselves were no longer adequate indicators of relict channel age, unless they could be archaeologically demonstrated to be contemporary, either by specific contextual association or by absolute dating. Furthermore, their 'presence' was attributable, not to linear alignments, but to exposure by subsequent human activity.

Investigating rivers at system-wide scale

To understand the evolution of the river system and the relationship between fluvial evolution and human settlements, a large-scale perspective was necessary. Familiar with the usefulness of aerial photographs, in a working relationship between the Mesopotamian Alluvium Project (MAP), directed by Robert McC. Adams at the University of California-San Diego, and the Center for Ancient Middle Eastern Landscapes (CAMEL), directed by Wilkinson at the University of Chicago, Wilkinson and his students became early adopters of declassified CORONA satellite photography, as well as spatial analyses using Geographic Information Systems (GIS) (Casana and Cothran 2008; Hritz 2005; 2010; Pournelle 2003b; 2007; Ur 2003).[4]

First declassified and made publicly available in 1997, CORONA was advantageous for a number of reasons. It provided the overview of the entire alluvial plain that was necessary for systematic understanding of watershed dynamics, yet was of sufficient resolution to examine many features in detail. It was imaged contemporaneously with the extensive surveys conducted in the late 1960s, and thus could be compared with published results. Images covered the same areas over multiple years and seasons, so that features could be compared under varying light, moisture, and vegetation conditions. Coverage was available for the entirety of the alluvium, enabling comprehensive mapping of large-scale 'windows' of contemporary

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in Al Qadisiyyah Governorate of the upper alluvium, 20 km northeast of Nippur, just west of the meander scars depicted in Figure 16.4. The second, referred to hereinafter as Abu-Salabikh-in-Basra, lies in the Hammar district of Basra Governorate.

[4] This extremely productive relationship was initiated by G. Algaze, then chair of UCSD's Department of Anthropology. In 1999, at Adams's urging, he encouraged that department to host Wilkinson for a joint workshop: Co-author Pournelle, formerly a U.S. Army photo interpretation unit commander, introduced means and methods for acquiring, digitising, and interpreting recently-declassified CORONA imagery of the region. Wilkinson conducted seminars on landscape archaeology of Mesopotamia and the Middle East. Wilkinson and Pournelle reviewed CORONA relevant to Wilkinson 2003. Thereafter, in a series of joint seminars, both institutions (jointly and widely) shared imagery, techniques, and results with the aim of accelerating their long-overdue adoption into archaeology of the region.

features within the landscape palimpsest — and all this at a time when such 'virtual' survey was essential, since Iraq was closed to all foreign, and most national, archaeologists (Hritz 2010; Pournelle 2003b; 2007).

At both institutions, students grappled with technical challenges posed by archived CORONA, even as they conducted comparative studies that relied on other, non-contemporary, multispectral imagery (such as LANDSAT, ASTER, SPOT), and later, high-resolution imagery marketed by Digital Globe (IKONOS, Quickbird, GeoEye, and WorldView) better suited to more specific analysis of soil types, vegetation cover, thermal variation (as a proxy for ground moisture), and topography. The co-authors of this chapter focused especially on the unique interpretive challenges posed by the alluvial landscape south of Baghdad — Hritz on the upper alluvium, Pournelle on the lower — where the rivers had clearly moved the most, and most often, throughout the Holocene.

The degree and variability of that past movement is illustrated by a series of deeply buried flow regimes — none visible at surface, except for a few patches of the most recent — reconstructed from sand fraction data logged in over 300 test wells cored the length and breadth of the alluvium (Jassim and Goff 2006: 190) (Figure 16.5). Rather than mapping riverbeds *per se*, a high percentage of sand in each depth slice indicates zones of repeated sand deposition at the broad margins of flood zones, where water-transported sand settled out as floodwaters slowed and spread. Over time, during dry periods, these soils were re-worked by winds.

Lighter silts were transported long distances, while larger-sized, heavier sand particles remained within a few kilometres of their point of deposition, concentrating the sand fraction and 'stacking' sand within each section.[5] While undated, these changes in sand deposition provide deeply buried evidence for multiple, dramatic flow regime transitions since the late Pleistocene, with the lower plain (south and east of Jemdet Nasr) displaying shifts over a geographical area *triple* the breadth of the upper.

To begin elucidating such changes, for archaeological 'ground-truth,' we initially relied on the aforementioned published archaeological surveys; the original field notes from which they were derived; excavation reports; WWI, WWII, Cold War, and Gulf War-era topographical maps; and detailed soil maps and soil survey reports (originally contracted for the agricultural irrigation programmes discussed in the introduction to this chapter), recovered piecemeal from various archives and personal collections in Britain and Europe (Hritz 2005; 2010; Pournelle 2003b). Following Wilkinson's methodology in examining (and re-examining) this material, Pournelle used high-resolution Digital Terrain Elevation Data (DTED) coupled with ASTER thermal imagery to test whether Wilkinson's conclusions regarding channel burial and exposure between Nippur and Mashkan-Shapir could also be discerned from imagery (Pournelle 2003b: Fig. 56).

This exercise confirmed that watercourses in the central alluvium that previously had been presumed by Adams and others to be both connected and contemporaneous could not have been. As shown by Paepe further north, such 'connection' would have required stratigraphically earlier channels to flow uphill, over later levees. ASTER analysis showed that the Uruk Period sites along the western edge of Lake Dalmaj northeast of Nippur, presumed by Adams to be contemporaneous with a large, highly visible meander scroll there, were in fact pedestalled well above it — a fact now clearly visible to even the casual observer on 2011 Digital Globe imagery (Figure 16.4). Thus, this scroll — which equally clearly disappears *beneath* later alluvial accumulations in less-deflated areas — could not have been connected to the post-Uruk river system as hypothesised by Adams and his successors.[6] Similarly, what had previously been postulated, based on settlement distribution, to be a political buffer zone between clusters of Early Uruk sites on the central agricultural plain (Adams 1981; Pollock 1999), was better explained by differential site visibility — a result of the high degree of surface deflation on either side of a substantial levee last active during the Ottoman era, beneath which no excavation had ever been conducted that might have revealed buried sites (Pournelle 2003b: 152–153). And while large, textually-attested man-made features such as relics of the 'Iturungal' canal between Nagsu and Uruk were revealed by that selfsame deflation, the genesis, use, and re-use of such features was less than straightforward: not one, but *three* parallel and partially overlapping 'Iturungal' canals were rendered visible (Pournelle 2003b: fig. 62).

The 2003 Gulf War lead literally overnight to public release of theretofore highly-classified commercial digital imagery, concomitant with release of imagery-based tools allowing broader-scale three-dimensional modelling of what had been largely perceived as two-dimensional terrain.[7] Further, over the next several

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[5] So much so that wind-blown, sand-sized particles of clay and silt ('pseudo-sand') piles into barchan dune fields on arid portions of the Iraqi alluvium (see Awadh 2012; MacDonald and Caldwell 2005; Yousouf *et al.* 2010). While lower and less dramatic than Arabian and Saharan sand dunes that form atop ancient ocean beds, they can be sufficiently large to obscure entire ancient cities, such as Umma. See Adams 1981: 30.

[6] At the UCSD MAP–OI CAMEL joint workshops, on numerous occasions Wilkinson himself assessed that, based on their size, depth, and sinuosity, they probably dated to the fluvial late Pleistocene.

[7] The Keyhole Earth Viewer, purchased and further developed by CIA venture-cap firm In-Q-Tel in 2003, became Google Earth in 2004.

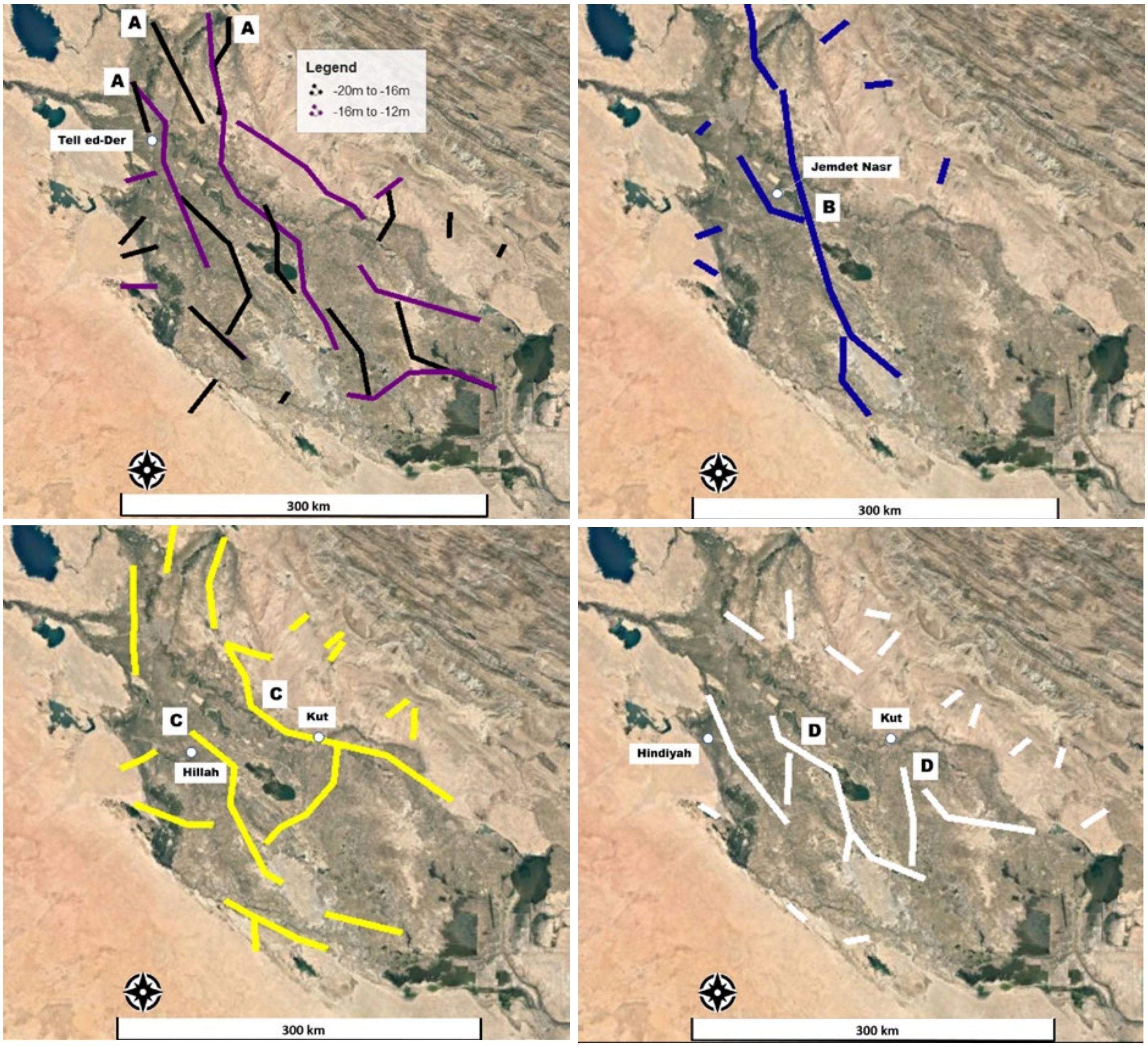


Figure 16.5. Pleistocene–Holocene sand stacking (after Jassim and Goff 2006: 190). Sand, deposited as fast-moving water slowed provides deeply buried evidence for multiple (but undated) flow regime transitions. Lines do not represent riverbeds; rather zones of repeated sand deposition at the limits of peak flood zones. City names provided for reference only: no channel association should be inferred. A. -20 to -12m. Tigris, Diyala, and Euphrates watersheds flow into the alluvium north of Tell ed-Der as separate channels, then consolidate into parallel flow regimes. B. -12 to -8m. Diyala and Tigris merge, joined by the Euphrates south of Jemdet Nasr. C. -8 to -4m. Tigris and Euphrates separate, the Tigris into its current bed (with a splay at Kut); the Euphrates into its Hillah (eastern) branch. D. -4 to 0m. The Euphrates avulses into its Hindiyah (western) branch; the Tigris forms additional splay channels near Kut.

years, abstracts and synopses of Iraqi-conducted geological and sedimentological studies of the alluvium conducted during the embargoed 1980s–1990s began to become available to the international sphere. At system-wide scale, Wilkinson pioneered the use of Digital Elevation Models (DEMs) derived from the Shuttle Radar Topography Mission (SRTM) for alluvial Mesopotamia (Hritz and Wilkinson 2006). This topographically informed reconstruction enabled re-analysis of survey and cuneiform textual data, where previous analyses had produced conflicting pictures. The work showed that it was possible to use topographic data with imagery overlays to sequence canal channels, untangle channel development, and estimate relative contributions of individual rivers to the watershed.

Understanding the potential public relations value of real-time imagery fly-downs, Keyhole-In-Q-Tel-Google pushed for declassification and release of downgraded imagery for near-real time news feeds in time for the invasion of Iraq on March 20 of that year. Overnight, imagery previously unavailable to the public was shown on the morning news, and earning Google Earth the nickname ‘21st-century metal detector’ as it became everyman’s archaeological site-hunting tool.

Wilkinson described the evolution of watersheds and irrigation systems of the Mesopotamian alluvium as a landscape of naturally anastomosing rivers, avulsing channels, and slow-moving marshes. Early communities could take advantage of this diversity, and initiate irrigated grain cultivation along levee crests, where the well-drained soil was most productive (Postgate 1990). This process formalised and extended field systems, so that over time, the mosaic became more managed, transforming a 'natural landscape' into a 'cultural' one (Wilkinson 2013: 42). However, natural elements of the landscape always remained, and were re-used and re-managed to maintain their resource-generative capacity (Hritz 2010; Hritz and Wilkinson 2006; Wilkinson 2013). The guiding force of these cumulative changes was the dynamics of the rivers themselves, as influenced by the activities of continuous occupants on the plains.

Wilkinson's work in Southern Mesopotamia illustrated its complex landscape stratigraphy, showed how to identify ecofacts and recover evidence for irrigated agriculture, and provided an outline for the geomorphological evolution of hydraulic and irrigated landscapes, opening the door to significant new research. Returning to fundamental questions pursued by Jacobsen and Adams, Hritz explored the location of the Tigris river over the 5th–3rd millennium BCE in light of the spatio-temporal heterogeneity of sedimentation and erosion over the Akkadian upper alluvium (Hritz 2010), as well as the potential for site association to classical-era river channels through unsurveyed belts of the southern marshes (Hritz 2007). Since 2003, Pournelle has mapped visible remnants of the Sumerian river systems (Pournelle 2003a; 2003b: see fig. 7), explored relationships among river avulsions, marsh formation, and urban resilience throughout the alluvium (Pournelle and Algaze 2015), and the interplay among marine transgression/recession (Gulf head location), marsh formation, and the cultural ecology of urban systems in the southern alluvium (Pournelle 2007; 2012).

Beginning in the upper alluvium, Hritz 2010 demonstrated that the Islamic-era Nahrwan canal, located northeast of the current Tigris River, re-adopted and made use of an earlier abandoned river channel levee. Visible as a topographic ridge on STRM imagery, the earlier levee is distinct because it is much wider, more sinuous, and taller than that of the relict canal. The landscape where the modern Tigris and Diyala rivers join is an area of heavy, long-term fluvial sedimentation, and extensive, on-going cultivation also works to both bury and erode features in the same area (see Adams 1965: 119–125). Despite these impediments to landscape visibility, several observations can be made that contribute to the broader picture of the river system. First, the size and form of the relict levee reused by the Nahrwan indicates the presence of a large river – one that conducted more flow than either the Nahrwan canal or the Diyala (see Hritz 2010 for detailed discussion). This river could have been a primary distributary of the Tigris. Second, analysing the spatial relationship between the channel, surveyed sites, *and* topographic data in a GIS, it is reasonable to assign this levee to a date range of 5th–3rd millennium BCE. Finally, this relict levee terminates at the modern bed of the Tigris River in the vicinity of Kut, where the Shatt al-Gharraf begins.

The implication of these observations is that, consistent with Jacobson's reconstruction, during fundamental periods of Mesopotamian urbanisation, a large primary channel of the Tigris River *was* located in the Diyala river valley, and *not* on the central plains. But more importantly, for inhabitants southward from that valley, the great westerly reliance on the Euphrates river could have been balanced by the easterly presence of a leveed, rather than incised, Tigris — enabling the extension of cultivation into this area during historical periods earlier than previously assumed, and accounting for the high population levels described in texts of the latter 3rd millennium BCE From that area (e.g. Sharlach 2004). Further, in this tectonic setting, leveed Tigris channels would at that time have behaved more like 'the' Euphrates, anastomosing as it changed elevation through the Diyala basin (rather than adopting a single stream as it does today), then avulsing and branching as it passed over slip faults (as it does south of Amara today) (Pournelle 2012: fig. 1.1a).

This reconstruction of the Tigris not only fits the channel outline described by Jacobsen, but also other reconstructions that are typically considered conflicting – but 'conflicting' only because a single channel is assumed. For example, by correlating toponyms from cuneiform texts to the term used to designate the Tigris, Piotr Steinkeller postulated a later 3rd millennium BCE river that ran from the northeast, past the Old Babylonian site of Maskan Shapir and through Lake Dalmaj, to Umma and onward to Lagash (Steinkeller 2007: 199). But Pournelle (2007) and Hritz (2010) demonstrated that a single line drawn from the northeast is topographically problematic, would require water to run uphill, and is based on the conflation of features from different time periods. However, the term for 'Tigris' could instead refer to a secondary channel coming from the north, and a leveed Tigris with multiple channels (as seen today from Amara to Qurna) can accommodate the complexity and differences between the textual accounts and the archaeological record.

Such a Tigris model also makes consistent geological sense when compared to reconstructions of the better- (if imperfectly) studied Euphrates, where in some areas

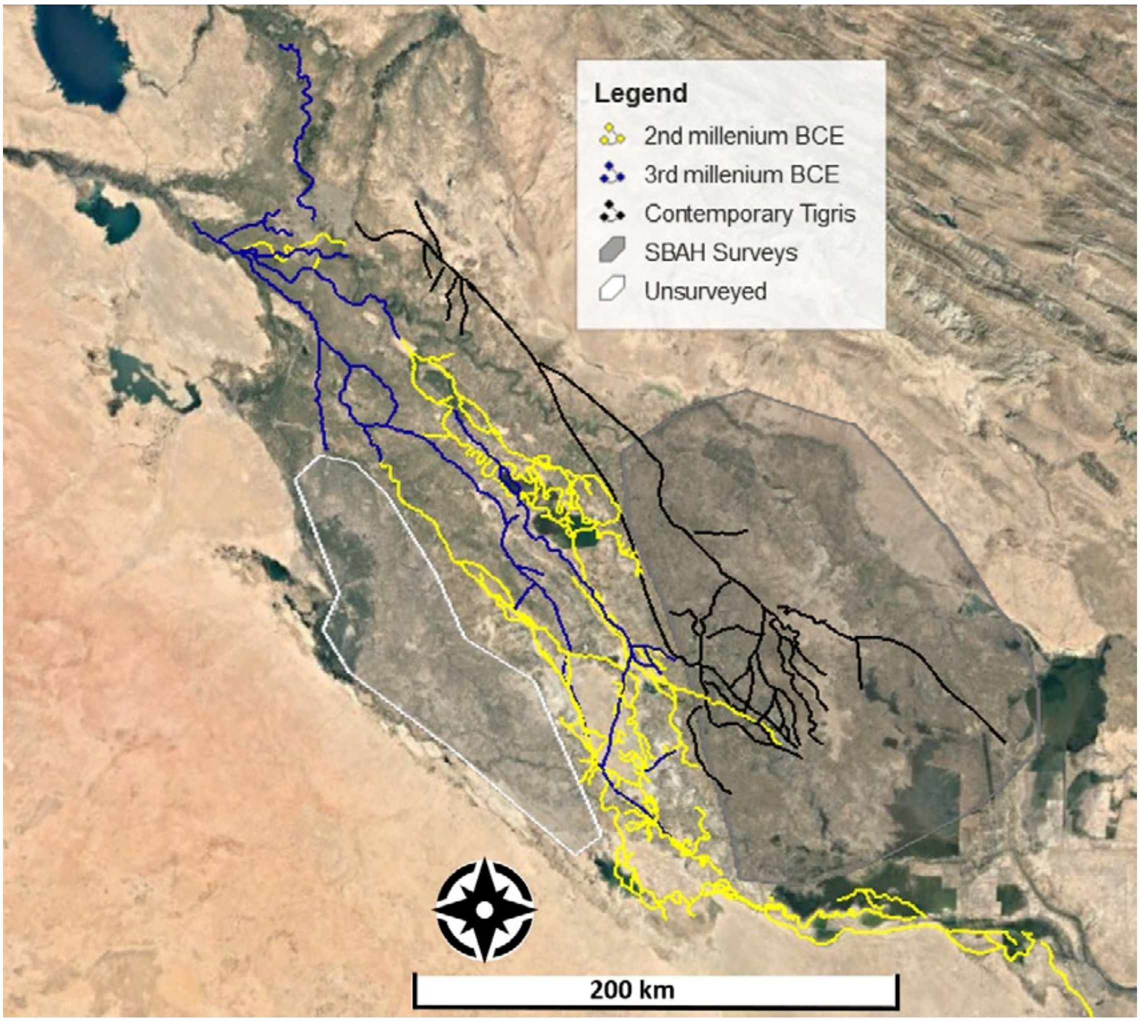


Figure 16.6. Visible levees and watercourses of the Tigris-Euphrates river system, 3rd–2nd millennium BCE. White-bounded area is unsurveyed. Grey-bounded area was remotely sensed; levees detected on SRTM, DTED, and ASTER DEM were associated with potential site clouds detected on CORONA and Quickbird imagery (Hritz 2007; 2010; Hritz and Wilkinson 2006). Depending on gradient, note tendency of rivers to (A) divert beds, (B) anastomose, and (C) splay as their beds interact with sub-surface faults.

aeolian deflation (Figure 16.4) has provided windows of visibility into its 5th–2nd millennium BCE evolution (Figure 16.6). As discussed in detail elsewhere, on the middle alluvium, long-lived cities tended to form at the heads of river splays, which afforded them access to a variety of resources in addition to levee-top cultivation (Pournelle 2003a; 2003b; 2012; Pournelle and Algaze 2015).

The role of the Shatt al-Gharraf can be clarified in this picture as well (Hritz 2010; Figure 16.6). Throughout the 1960s, provincial representatives of the State Board of Antiquities and Heritage surveyed archaeological sites throughout Southern Iraq and compiled them into a large catalogue (Al Haik 1968; Iraq DoA 1976.) While Adams and other foreign archaeologists were not able to survey edges of the Central, Hammer and Hawiza marshes at that time, Iraqi archaeologists had access and resources to conduct some reconnaissance along and southeast of the Shatt al-Gharraf itself. A similarly broad, high, and long-lived levee to that underlying the Nahrwan, the Gharraf supported archaeological sites dating to at least the mid-5th millennium BCE (Carter 1989; Genoillac 1934; Nadali and Polcarno 2016; 2018). Comparing the morphology of its levee with those of both the modern Tigris and the Nahrwan, as well as noting the spatial distribution of archaeological tells, the Shatt al-Gharraf likely represented a large Tigris river branch, perhaps even connecting to the Euphrates in the early 3rd millennium BCE and in any case constituting a delta in this period (as suggested by Pournelle 2012), with secondary distributaries continuing to the south and east to feed the burgeoning cities of Lagash and Nina (see Hritz, Pournelle, and Smith 2012: 39–40).

Neglected geological controls

Throughout the 20th century, insofar as geomorphologic processes were considered by archaeologists of Lower Mesopotamia, the primary concern was with sediment dynamics. Adams saw ancient irrigation projects as purveyors of sediment into the central alluvium. Others, concerned with the likelihood of archaeological recovery, attempted to estimate and/or map accumulation depths (Nützel 1978). A century-long discussion regarding the location at any given time of the head of the Gulf in relation to the location of ancient Southern Mesopotamian cities focused on the competing forces of sediment deposition and sediment compaction in determining the location of the relative shoreline.

Ironically — given the broad geological acceptance of plate tectonics since the 1960s, which render moot the (geologically minor) contributions of sedimentation to plain elevation and river dynamics in the lower alluvium, as compared to (geologically major) contributions of Mesopotamian plate deformation beneath the crustal uplift that is the Zagros range along Iraq's eastern border with Iran — canonical mid-century works in these discussions (De Morgan 1900; Lambeck 1996; Larsen and Evans 1978; Lees and Falcon 1952; MacFayden and Vita-Finzi 1978; Nutzel 1978; Vita-Finzi 1978) are still 'authoritatively' cited by archaeologists following humanist discursive traditions — even where their framing intent (to examine the interaction of anthropogenic and 'natural' processes on river evolution) has been forgotten. Meanwhile, geological research in Iraq has moved on, making clear that processes of sediment aggradation, compaction, drainage, and deflation are, beyond only very broadly generalisable spatial trends, highly localised and specific.

Abiding questions remain: how much, how fast, how deep, when, and why. That is, (1) With what water volume and rate of flow did alluvial denizens contend at any given space and time? (2) At what level, above or below plain, did water flow? (3) When did abrupt shifts in the rivers' overall flow regimes occur? (4) What were the primary controls on those shifts? Those concerned with the long histories of specific sites and dynasties have for the most part focused on local controls: the processes of interaction among sedimentation, levee-cutting, floods, and diversions near excavated sites. Because these processes were demonstrated at multiple individual locations, following Adams, there emerged a consensus that the aggregation of agricultural activities on the central plain built up the plain level, thus 'forcing' the rivers eastward and westward into their current beds. The argument went: water drawn through the levees to irrigate downslopes slowed as it spread over fields, dropping its sediment loads in the process and thus (over time) building up the plain below.

This argument rested on two assumptions. The first: if and when agricultural activities accelerate sediment deposition (which for the sake of this discussion we will take as a given), the primary (or even a major) locus of deposition would necessarily be on the levees themselves, and once deposited they would remain on the central plain. The second: without interaction with irrigation systems, the rivers would not have built up their own beds sufficiently for high floods to trigger them to join, separate, or move into alternate beds of their own accord. But *was* channel migration primarily (or largely) anthropogenic? To answer that question, we must re-introduce into the discussion that largely ignored primary process: tectonics, which has a profound impact, at both broadly regional, and very local, scales. Perhaps bizarrely, archaeological attention to the overwhelming quantity of oil development-sponsored geological research on the interaction of subsurface tectonics with surface features has been virtually non-existent. But understanding those interactions is vital.

At basin-wide scale, it might be presumed that the Tigris would tend to be pushed *westward* by tectonic uplift of the Zagros Mountains, and require some intervening process to *force* it eastward, out of the centre of the plain. That was certainly Adams's view. But counter-intuitively, the weight of those mountains warps the eastern edge of the Mesopotamian basin *downward*, so that, unless *pushed* westward toward the Euphrates — by the buildup of alluvial fans washed down from the Zagros — since the early-mid Holocene the predominant 'natural' trend of the Tigris has been to join its tributaries in its current bed, or older beds to the *east* of its current position (Figure 16.7). Indeed, any anthropogenic influence on its course would be from *upslope* farming and husbandry in the Zagros, which, by accelerating hillslope failure and erosion (Kouchoukos and Wilkinson 2007), did indeed tend to force the river *toward* the central plain, not eastward and away from it. Add to this newer work completed along the Karun (see Heyvaert, Verkinderen, and Walstra 2013), and there exists considerable evidence that this has indeed been the case.

Along the Zagros upthrust, the points of 'breakthough' for these alluvial fans are a series of stress- and step-faults along the high Zagros folded zone. It is these that allow major tributaries — indeed the Tigris itself — to pass through the Diyala ridge (out of any southeast trending folded bed) and run downslope through Luristan and Khuzestan into the Mesopotamian basin (Sura et. al 2011; Yacoub 2011a; 2011b). Geologically minor variations in these faults thus have potentially major impact on where and when these rivers enter the

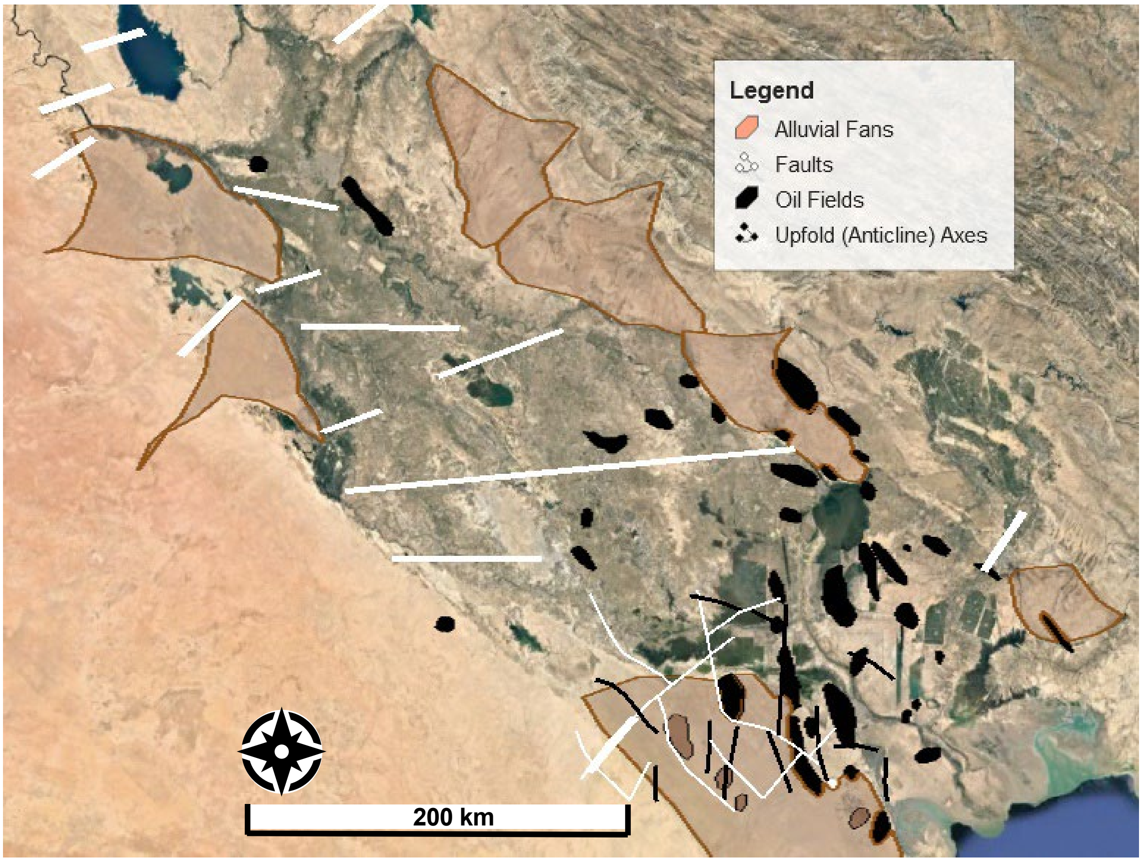


Figure 16.7. Tectonic controls on alluvial hydrology. Given the extremely low gradient along the axis of the Mesopotamian delta, even barely-measurable subsidence or uplift along step faults near Hit, Falluja, Musayib, Kerbala, and along the Diyala become specific loci for major Euphrates diversions. Likewise, slippage along faults crossing the plain on axes from Najaf to Kut, Shurrupak to Amara, and Samawa to Uruk trigger channel avulsions and splays (in conformity with local gradients) at recurring locations. In the far southeast, both factors, plus local salt domes-and-depressions, squeezed between anticlines coincident with the oilfields depicted here, lead to crevasse splays with highly unstable banks and highly variable channels. The Tigris tends to run along the base of Zagros alluvial fans, until these fans become sufficiently built up to move its bed westward. Base image: LANDSAT 2014, courtesy Google Earth Pro.

plain. Again, the primary anthropogenic interaction with these 'emergence points' is related to agricultural activity (and concomitant sediment erosion or aggradation) *within* the folds, not on the Mesopotamian lowlands — as attested by changes in the courses of the Karkeh and Karun Rivers over the past two millennia (Cole and Gasche 2007; Heyvaert and Baeteman 2007).

Proceeding downstream from their sources, changes to the rivers' flow volumes and gradients determine their overall form (braided, anastomosing, splayed) — but this does not tell us precisely *where* an avulsion will most likely occur, or if occurring, most likely lead to actual channel formation or diversion. Because such avulsions are often disastrous for intensively-managed irrigation and flood control systems, in the context of the Mesopotamian alluvium, it is especially worth noting which *particular* areas were most prone to bank instability, gradual channel separation, and 'channel flipping' among beds. On the plain itself, and along its western margin, horizontal (west–east) strike-slip faults are enduring loci for weakened banks, prone to avulsions (Pournelle 2012; Pournelle and Algaze 2015; Wilkinson 2012; 2013).

When the entire visible system is depicted, the overarching tectonic controls become apparent (Figure 16.8). Depending on gradient, both rivers tend to divert their beds and anastomose (upper alluvium), and splay along slips (middle alluvium) as their beds change gradient and interact with sub-surface faults. Among others, the enduring channel migration and fanning points seen at Hit, Sippar, Shurrupak, Zabalam, Uruk and the entry to the Eridu Basin, as well as the modern cities of Kut and Amara, are all thought to lie above slip faults passing west–east across the basin (Figure 16.6).

Table 16.1. Lower Euphrates River dates (AMS ^{14}C Radiocarbon and Optically Stimulated Luminescence [OSL]).

Organic-Rich Sediment						*Oxcal 4.4, INTCal 13, 95.4% confidence			
Locus	**Depth m**	**Sediment Description and Context**	**Lab No.**	**^{14}C age BP**	**Cal B(CE)***	**Lab No.**	**Locus**	**OSL age ± 2σ (ka)**	**Cal B(CE)***
Kuara (Tell Lahm): OSL Short Cores and Dose Rate Blocks									
TL-Red	15 msl-1.1m	Greyish red (Munsell 7/6) clay from pit of TL-DR-1	AA101210	5169 +/- 42	4053–3928				
TL-DR-1	15 msl-1.1m	Red (Munsell 6/6) denuded mud brick from NE edge of high mound, with white gypsum inclusions.	AA101211	4613 +/- 40	3520–3332	USU 1389	TL-OSL1	2.51 ± 0.60	490-(430)
TL-DR-2	8 msl-1.1m	Reddish grey (Munsell 7/5) rounded, pea sized clay from Irrigation cut at south edge of Tell	AA101212	2233 +/- 36	387-204	USU 1387	TL-OSL2	1.75 ± 0.44	130-(1030)
TL-DR-3	8 msl-1.1m	Gey (Munsell 7/5), angular, lentil-sized silty clay from small mound NW of Tell	AA101213	3074 +/- 38	1496-1231	USU 1388	TL-OSL3	3.36 ± 0.65	2480-720
West of Bit Iakin (Tell Abu Salabikh-in-Basra): Short Core									
AS-3	.25	consolidated clay from southern (younger) limit of point-bar	AA104274	4039 +/- 48	2854-2697				
AS-5	.25	consolidated clay from northern (older) limit of point bar	AA104276	4880 +/- 46	3774-3536				
East of Bit Iakin (Tell Abu Salabikh-in-Basra): Section Sample									
	1.1	Grey clay from canal cut east of point bar		n/a		USU 1364	OT-OSL2	1.41 ± 0.47	(604-751)
	3	Grey clay from canal cut, eastern (youngest) point bar		n/a		USU 1365	OT-OSL3	2.86 ± 0.74	1550-106
Rumayla: Short Core									
R-1	.43	Green, water-laid silty clay	AA104289	905 +/-34	(1035-1208)				
R-11	1.05	Green, water-laid silty clay	AA104290	2201 +/-37	(376-177)				
R13B	1.12	Green, water-laid silty clay	AA104291	4033 +/-45	2849-2465				
R-14A	1.18	Grey-green, water-laid clayey silt	AA104292	3828 +/-40	2458-2147				
R-14B	1.18	Red, fluvial clayey silt	AA104293	5854 +/-58	4842-4552				
R-18	1.42	Red, fluvial clayey silt	AA104294	6075 +/-51	5207-4842				
Hareer: Section Samples									

2-H4	1.25	Reddish silty clay with powdered shell fragments	AA104298	3009 +/-29	1385-146
1-H2	4.25	reddish clay with powdered shell fragments	AA104296	5786 +/-35	4717-4546
4-H8	4.8	Reddish clay with powdered shell fragments	AA104302	7700 +/-55	6638- 6466

Shell					*Oxcal 4.4: INTCal 95.4%; SHCal 13, 85% confidence.					
Locus	**Depth m**	**Type**	**Specimen Name**		Multi-proxy **Habitat**		**Cal B(CE)**			
			Common	**Latin**		**Lab No.**	**^{14}C age BP**	**IntCal13**	**ShCal 13**	**Diff y**
Eridu (Tell Abu Shahrain) (Hritz, Pournelle, Smith, *et al.* 2012)										
EP3-3	0	gastropod	Melania snail	Melanoides tuberculata	Fresh-brackish marsh	AA94632	3991 +/- 38	2621-2321		
EP3-2	0	gastropod	Melania snail	Melanoides tuberculata	Shallow fresh marsh	AA94631	4064 +/- 39	2855-2481		
EP3-1		gastropod	Melania snail	Melanoides tuberculata	Shallow fresh lake	AA94630	6169 +/- 43	5284-4994		
EP3-4		gastropod	Melania snail	Melanoides tuberculata	Quiet, shallow fresh lake	AA94633	6845 +/- 45	5837-5644		
Ur (Tell Al-Muqayyar): Surface Collection										
Ur-1	0	gastropod	Melania snail	*Melanoides tuberculata*	fresh–brackish	AA100241	4054±44	2697–2473	2678-2435	19-38
Ur-2	0	gastropod	Malania snail	*Melanoides tuberculata*	fresh–brackish	AA100242	4128 ±44	2872–2579	2866-2488	8-91
KIssiga (Tell Lahm): Surface Collection										
TLD-3	0	gastropod	Melania snail	*Melanoides tuberculata*	fresh–brackish	AA101213	3074 +/-38	1426–1231	1411–1188	15–43
TL-1	0	gastropod	Persian conch	*Conomurex persicus*	Low energy shallow bays	AA101207	4689 ±35	3529–3370	3523–3553	6–17
TL2	0	bivalve	True oyster	Ostreidae sp.	Estuarine/ intertidal	AA101208	5340 ±37	4264–4250	4252–4034	12–16
TL-3	0	bivalve	Scallop	*(Try)Cardium enode*	Shallow benthic (seagrass)	AA101209	5426 ±35	4348–4233	4336–4222	12–11
Chubayish: Section Samples					Two sections. Corresponding strata matched by shading.					
		Context and Specimen Dated			Multi-proxy Habitat					
C1-5	.7	Top of peaty layer with gastropods; predominantly *Melanopsis*			fresh marsh	AA104281	1951+/-40	(41-148)	(41-211)	0-63
C1-3	.9	Top of water-laid grey silt with mixed gastropod shelly inclusions; predominantly *Melanoides;*			fresh–brackish shallow lake	AA104279	2028+/-40	163-(59)	68-(115)	95-56
C1-2		Extracted block with bivalve & gastropod spat; reed fragments			fresh marsh	AA104278	3148 +/-46	1507–1292	1462-1257	45-35

C1-4	3.3	Top of red layer with bivalve spat			brackish marsh	AA104280	3715 +/- 43	2277–1976	2199-1926	78-50
C2-1	.8	Base of peaty layer with mixed gastropods; *Melanoides*			fresh marsh	AA104282	565+/-38	(1300-1431)	(1324-1449)	24-18
C2-3	.9	Shelly, water-laid grey silt layer with mixed gastropods, *Melanoides; Melanopsis*			fresh–brackish shallow lake	AA104285	2039+/-40	166-(51)	100-(111)	66-60
C2-2A	3.3	Top of red layer: nodular grey silt w/ sand, shell inclusions; *Corbicula*			brackish marsh	AA104283	3842 +/-43	2463–2153	2456-2050	7-103
Hareer: Section Samples										
1-H1	0.25	Grey silt with shell inclusions *(Bellamia, Melanoides)*			fresh lake	AA104295	802 +/- 38	(1167-1276)	(1206-1301)	39-25
2-H3	1	Grey clayey silt with shell *(Melanopsis, Melanoides)*			brackish	AA104297	1854 +/- 39	(69–245)	(114-259)	35-44
4-H7	4.2	Grey silty clay with shell inclusions *(Corbicula)*			brackish	AA104301	591 +/-36	(1296-1415)	(1318-1440)	22-25
3-H5	0.6	Reddish clayey silt with shell *(Melanopsis, Melanoides)*			fresh	AA104299	1420 +/-37	(568–665)	(591-690)	23-25
3-H6	1.1	Grey clayey silt with shell inclusions *(Melanoides)*			fresh–brackish	AA104300	2217 +/ -38	385–196	370-132	15-64
Charax Spasinou (Khayabir): Surface Collection										
CS-1	0	gastropod	Persian conch	*Conomurex persicus*	Marine: slack shallow bay	AA104288	2769 +/- 38	1005-831	976-804	29-27
Forat (Mughlub): Looter Pit Section										
M-1	4m	rock coral	war coral	*Favites pentagona*	Marine: shoals, shallow reef	WHOI	2130 +/- 25	(207-88)	(199-54)	8-34

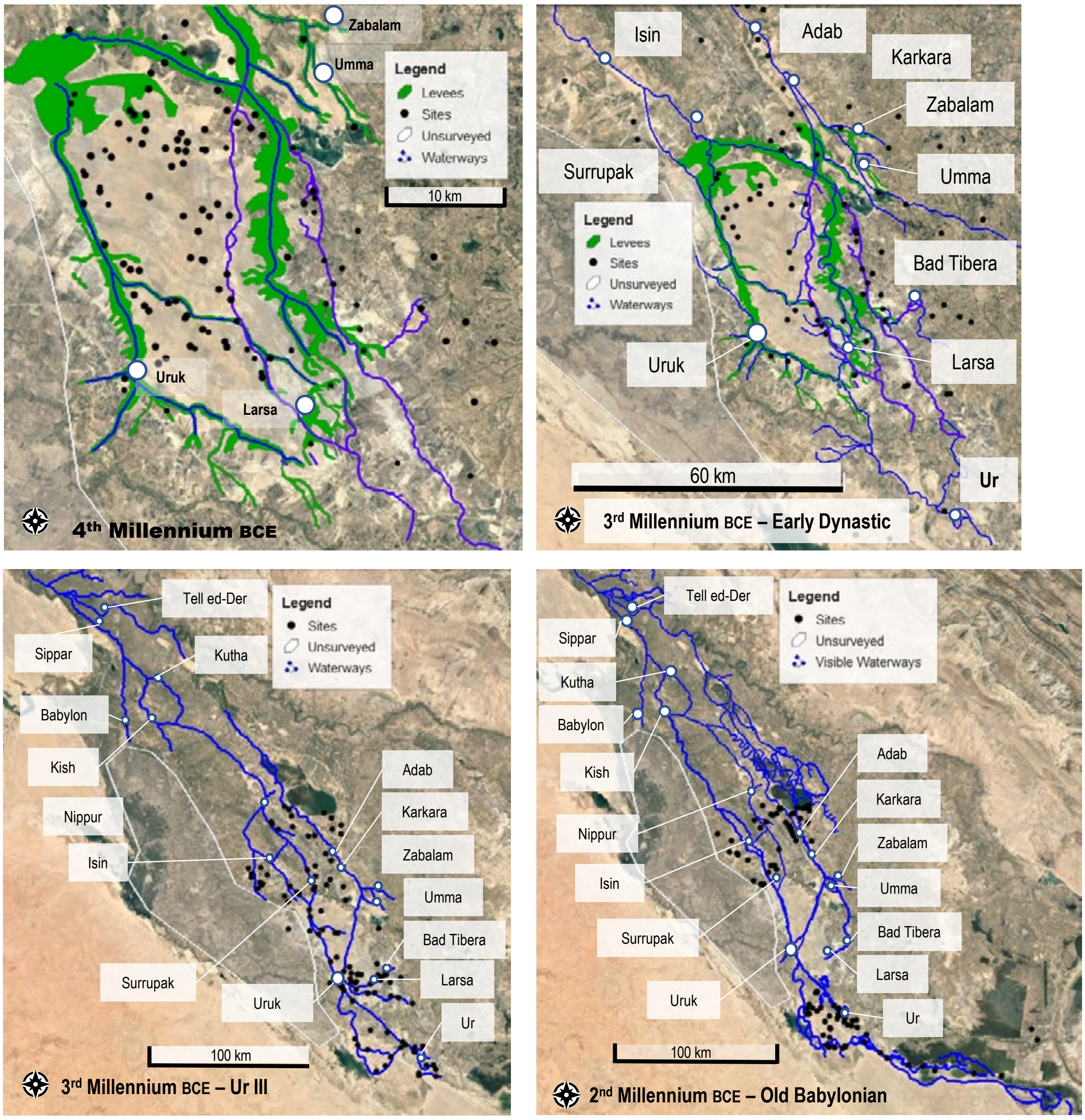


Figure 16.8. Visible evolution of the Euphrates system, 5th–2nd millennium BCE, as seen from the lower alluvium.

Three morphotectonically distinguishable zones are especially relevant to understanding the rivers' evolution (Figure 16.6). In the upper alluvium, subsidence or uplift along step faults near Hit, Falluja, Musayib, Kerbala, and along the Diyala can lead to major (and sudden) Euphrates diversions, such as those identified by Cole and Gasche (1998). In addition, alluvial fans from the Zagros, building over time — and accelerated by piedmont hill-slope agricultural activities (Walstra, Heyvaert, and Verkinderen 2010; 2011), not only constrain the floodplain and tend to push the bed of the Tigris westward; they deeply bury 5th–4th millennium BCE surfaces, rendering them largely invisible.

In the middle alluvium, slippage along faults crossing the plain along west–east axes from Najaf to Kut, Shurrupak to Amara, and Samawa to Uruk influences where channels will avulse and splay In the far southeast, the low gradient interacting with localised uplift of salt domes squeezed between anticlines (coincident with oilfields), lead to crevasse splays with highly unstable banks and highly variable channels. Moreover, thanks to 'windows' into earlier channel systems granted by the processes of wind deflation, levee formation, and differential soil hydration (Figure 16.8), we can see that — even when morphology differs, due to changes in gradient — the lines where channel movement occur are remarkably stable through time. Thus, while human manipulation of weak riverbanks does leave them even more prone to burst (avulse) during peak floods, it is the underlying strike-slip fault that defines the (naturally) weakest zones. In this extremely flat landscape, any slight lateral slip leads to

Table 16.2. Historical periods associated with archaeological sites of the Lower Euphrates, listed from west to east.

Millenium BCE:		**Third**			**Second**		**First**	
(Listed West to East)		**Early Dynastic**	**Akkadian–Ur III**	**Isin-Larsa**	**Old Babylonian**	**Kassite**	**Neo-Assyrian**	**Chaldean (Neobabylonian)**
City Name	**Site Name**							
Eridu	T. Abu Shahrain	X	X					
Ur	T. Muquayyar	X	X	X				X
Kisiga	T. Al-Lahm	X	X	X	X	X	X	X
	T. Jebara			X	X			
	T. Jadeda		X		X			
	T. Bint Al-Saiegh			X	X			X
	T. Jerbasi				X	X	X	X
Bit Iakin	T. Abu Salabikh	?	?		X	X	X	X
	Hareer							X
Charax Spasinou	Khyaber							?
Forat	Mughlub							?

avulsion; any slight downward strike creates a crevasse for the new splay to enter.

For southeastern Iraq, at the most local scale, such structures are geologically well studied —because they are particularly associated with their geological children: salt diapirs and oil reserves (Bordenave and Burwood 1995; Bordenave and Hegre 2005; Koyi 2008; Sherkati, 2005; Sissakian *et al.* 2017). Beneath the sediments of the southern alluvium, bedrock ripples and folds in a series of anticlines (ridges) running parallel to the Zagros. In the far southeast, between these, salt domes are squeezed upward through the comparatively soft sediments, creating surface bulges. The most dramatic of these is Jebel Sanam, the highest point in Southern Iraq, once used as a military signals post; now designated as a Geopark. Lesser diapirs are barely visible at surface, rising barely a metre above surrounding plain level (Al-Mutury 2014; Hritz, Pournelle, and Smith 2012; Jassim and Goff 2006: 93; Warren 2006: 707). This combination of folds and domes has profound influence on the sinuosity and flow of the Lower Euphrates as it wends its way to the Gulf — and has profound interaction with anthropogenic activities of a very different kind and order than previously discussed.

Alluvial cities and their hinterlands

In brief summary, most of what is known about cities of the Mesopotamian alluvium focuses on surveyed areas, and least is known about the far southeast. Beyond Akkad, beyond Sumer, the marshy realm between Sumer and Elam, known during the 2nd millennium BCE as 'The Sealands' or 'Mat Tamti;' thereafter as 'Chaldea' or 'Mat Kamki' with a capitol at 'Bit Yakin,' encompassed much of the now-dry Hammar marshes. Based on inscriptions from Tell Abu Salabikh-in-Basrah, Georges Roux suggested that this tell site, formerly at the centre of Lake Hammar (and now on the eastern edge of a remnant of the western Hammar marsh), was a seat of the historical figure Marduk-apla-iddina II (biblical Merodach-Baladan) — perhaps Bit Yakin itself — and the central metropolis of the area (Roux 1960). Always a place of refuge and sustenance, the Sealands, and their highly productive marshland lifeways, remain largely unexplored by archaeologists.

Mapping the lower euphrates

Beginning in 2010, in cooperation with the University of Basrah, we began an explicit landscape study that deployed geoarchaeological methods to tackle murky questions regarding evolution of the rivers, marshes, and Gulf shorelines in the former marsh zones that lie between ancient Sumer and Elam (Hritz, Pournelle, and Smith 2012; Hritz *et al.* 2012). Inspired by Wilkinson, using remote sensing coupled with on-location landscape analysis, our ongoing work aims to verify taphonomic processes, validate imagery interpretation methods in this new terrain, and collect palaeoenvironmental archives in order to meaningfully reconstruct the fundamental and structural transformation of settlement, economy, and land use in Southern Mesopotamia.

As noted above, the Euphrates River has undergone many channel diversions during its history, as a result of both its environmental setting and intentional human activity. The nature of the territory through which the river passes in its lower flood plain is the most important contributor to its constant shifts. Past channels are marked by the remnants of valleys, old stream beds, and buried riverine sediments, which

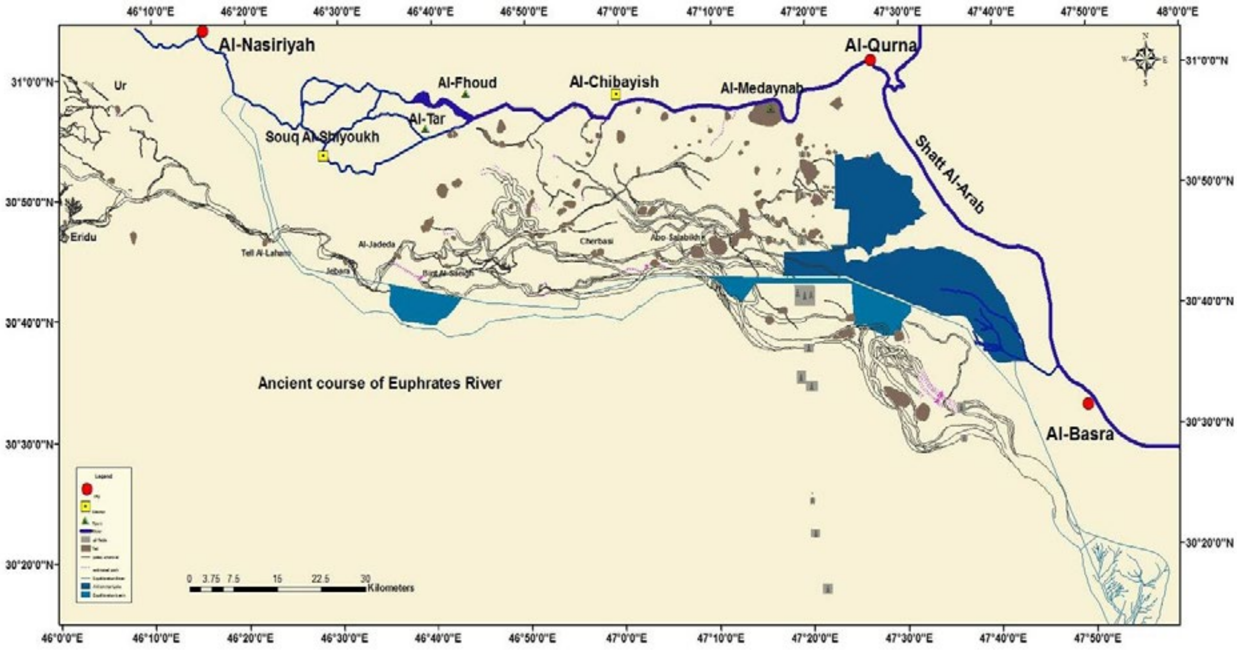


Figure 16.9. Courses of the Lower Euphrates, 3rd–2nd millennium BCE with archaeological settlements. Note the band of sites ringing the Hammar splay. Stars indicate sample points. (Figure: Nagham Darweesh Al-Hawi 2017).

themselves reflect great variations in the hydrological characteristics and contrasts in the geological and geomorphological settings of the Mesopotamian plain (Al-Mulla 2005). One of the most notable of these relict channels was pointed out by Fouad Safar (1981) during his excavations at Eridu in the 1950s, when he noted an ancient and wide course located to the west of the city (Al-Sakini 1993; Buringh 1957; Hansman 1978; Wilson 1925). This was mapped by Wright (1981) in several stages corresponding to archaeological periods, based on ceramic ages of sites located along its beds. All of these studies confirmed the existence of the relict course within the Eridu basin, but outside the basin it was mostly submerged under Lake Hammar, and remained unstudied.

This course enters the shallow Eridu basin from the northwest, extends along the curving edge of the western desert until it reaches Tell Abu Shahrain (Eridu), then passes to the east of the site to exit a gap in the sand ridge that defines the northern rim of the basin (Figure 16.7). It continues eastward along the southern edge of Al-Hammar marsh until it reaches the Khor Al-Zubair, to form with it a single channel flowing toward the Arabian Gulf (Figure 16.9). Because this channel so clearly (spatially and temporally) connects the entirety of the alluvium and many of its best-known sites, we considered it central to our research schema. This study is the first effort to fully map and date this feature and its many branches from the Eridu basin to Zubair. In new work presented here, we briefly consider two main lines of evidence: imagery and geoarchaeological. As for areas along the Shatt Al Gharraf, no systematic surveys are published, but sufficient reconnaissance has been conducted to record 3rd millennium BCE (in some cases earlier) tells in close spatial proximity to observed relict channels (Hritz 2007; U. Thi Qar/Marshes Rehabilitation Centre 2010).

A sedimentological framework was established through a systematic, multilingual literature review of published geological sections, cores, boreholes, and well logs from the surface to depths of 15–20 m, comprising lithofacies for approximately 230 sample points (Figure 16.10). For detailed study, geoarchaeological samples (fossil shells and sediments) were collected by the authors from ten sites. Sediments were collected from excavated off-site sections at two locations (Chubayish and Hareer); and by shallow, manually inserted PVC tube at two on-site and one off-site locations (Ur, Tell Lahm, and east of Tell Abu Salabikh-in-Basra); by shallow vibracoring at two off-site locations (west of Tell Lahm and west of Tell Abu Salabikh), and by shallow impact coring at one location (Rumayla). Fossil shells were collected from the surface or extracted from collected sediments.

Fossil shells and organic-rich sediments were dated by radiocarbon Accelerator Mass Spectroscopy at the NSF-Arizona AMS facility. Clay sediments with no significant organic content were dated by Optically Stimulated Luminescence (OSL) at the Utah State University Luminescence Laboratory (Table 16.1). For imagery

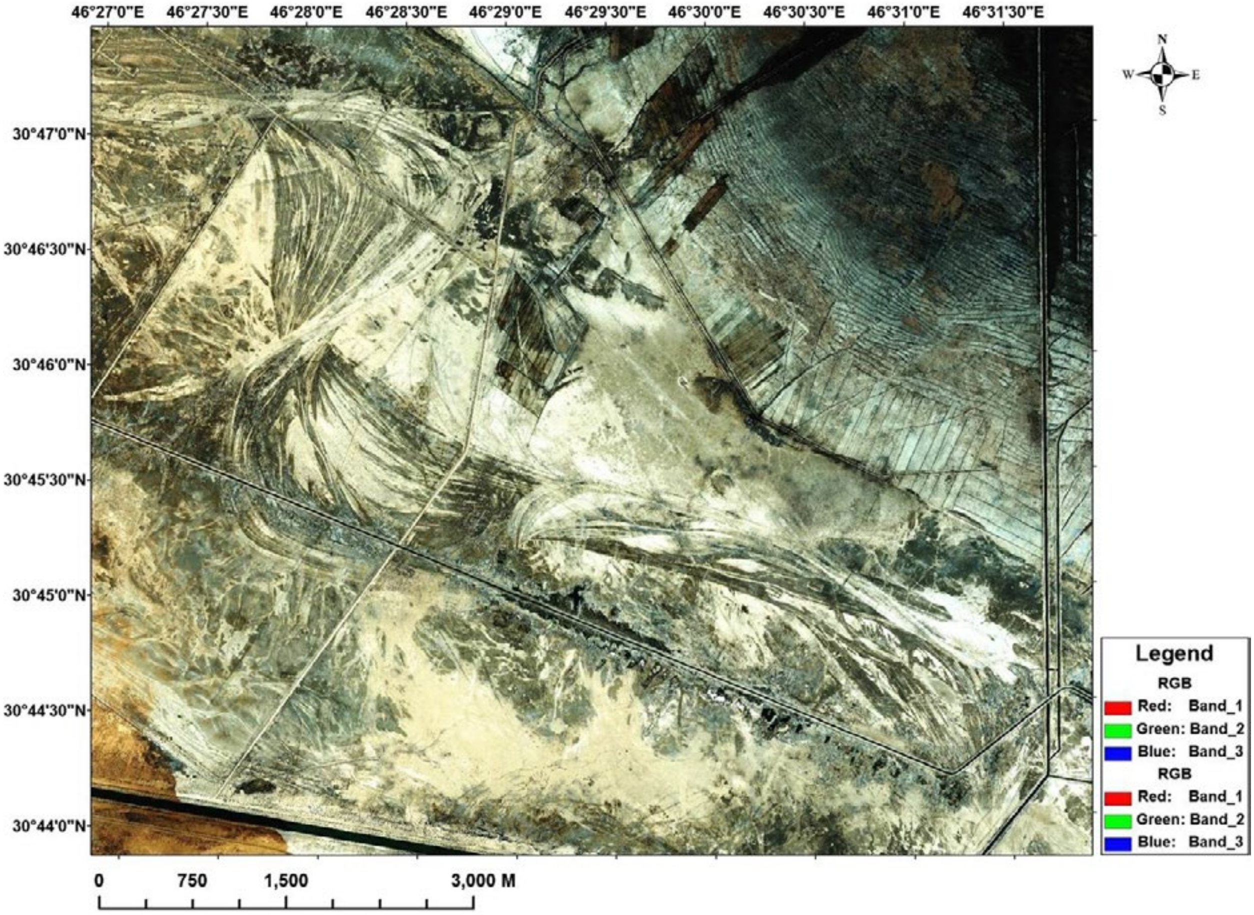


Figure 16.10. Locations of geoarchaeological cores, sections, and samples examined for evidence relevant to Lower Euphrates channel dating. Stars indicate those collected by the Sealands Archaeology and Environment Program. Inset: Meander scrolls indicating a relict course of the Euphrates. Source: QuickBirdTM 2006.

analyses, we relied primarily on high-resolution (0.6 m) Quick Bird™ satellite images (2006) provided by the Iraq Ministry of Planning, Basra Governorate. Any coverage gaps were supplemented with public Digital Globe images from Google Earth. One hundred and twenty scenes were selected to cover all of the study area. The high resolution enabled discrimination of the borders of archaeological mounds, architectural details within and near the mounds, and off-site features such as the remains of buildings, roads, irrigation canals, meander scrolls, point bars, buried riverbeds, and farmland field boundaries. No digital enhancements were required to use these images, but radiometric enhancements were used to help delineate less visible parts of relict canals and buried rivers, as well as to clarify the contours of small surface features.

A primary means of identifying a relict river course in this area, and the one used in this study, is by following continuous lines of meander scrolls as they transit the plain. Meander scrolls form when material is eroded from the concave portion of a meander, transported downstream, and deposited on the convex portion, or bar of a meander (Leopold and Langbein, 1966) (Figure 16.10: Inset). Results of this mapping effort are shown at Figure 16.9. The visible portions of these relict courses may be tentatively dated predominantly to the 3rd–2nd millennium BCE, based both on archaeological site association and absolute dating techniques.

Associated archaeological sites

To identify the spatial relationships between the relict course of the Euphrates and known sites, a map was drawn for each site based on geo-referenced imagery imported into ArcGIS (ArcMap) software. Site names were identified from a map prepared by the Marshes Rehabilitation Centre (2010) depicting 34 archaeological sites within Al-Hammar Marsh. Of these, those of known ceramic chronological date, as reported to co-author Al-Hawi by local Department of Antiquities representatives (from their updated site register: see Hamdani 2015) and situated in close proximity to the relict channel systems, were further examined (Figure

16.12). Of all sites believed-to-be inhabited during the 2nd millennium BCE, a clear trend in occupation age from west–east is apparent, from early 3rd millennium BCE in the west, through the 1st millennium BCE in the east (Table 16.2).

Whether this trend is due to actual differences in the eras of occupation, or due to differences in the degree of deflation of surrounding soils, is as yet unknown. Unlike the deflated central alluvial plains, in recently desiccated marshlands, the surface is protected by a thick silt-and-shell cap that obscures everything beneath. Even where recent polder cuts show archaeological remains in section, surface ceramic survey is possible only on the very tops of mounds disturbed by recent plowing or grave-digging. Therefore, given the thick crust of silt and shells obscuring most surfaces east of Tell Lahm, the latter explanation (differences in degree of deflation) cannot be discounted — and given Roux's observations a half-century ago at Tel Abu Salabikh-in-Basra, may even be likely. The sites examined, illustrated at Figure 16.11, included (Al Hawi 2017):

Eridu (Tell Abu Shahrain). The outer dimensions of the city of do not appear clearly on the satellite images, but the combined upper and lower mound has taken almost oval shape and is surrounded by a drainage channel. A relict watercourse surrounds the site in the western and southern sides, as do many other channels associated with the old river that spread to the west and northwest of the tell. This watercourse, mapped by Wright (1981), passes through the *hazim*, a sandstone ridge framing the Eridu basin, and continues eastward to Tell Al-Lahm.

Ur (*Tell Al-Muqqayir)*. The ovoid-shaped home of the ancient city is characterised by clear features in the satellite images. The ziggurat, tombs, and temples of the high mound, as well as other structures sprawled across the surrounding lower mound, can be distinguished. Many relict canals pass through and nearby the ancient city; the most prominent of these passes from the western mound, continuing around the southern end of the tell, and continues south-eastward to Tell Al-Lahm. These canals were previously identified by Wright (1981: fig. 3–13).

Kisiga (Tell Al-Lahm) appears as an oval form located along the same relict course of the Euphrates that passes Eridu to exit the Eridu basin. There are many interlaced channels passing both near to the tell and under it. The area of the main mound is about 768 m^2; a smaller mound is situated nearby. Pottery fragments, bricks, and wall fragments cover the surface of both these settlements; in some cases the linear arrangement of the fired bricks indicate buried walls.

Tell Jebarah (Osir Thamir) is located near Al- Khamesia village, about 13 km east of Kisiga and 37 km south from the current Euphrates River. It takes a rectangular to oval shape, and another settlement is situated above it. The overall site spans some 30 ha (Hamdani 2014: 15), while the area of the main mound is approximately 222 m^2, and the smaller mound is about 79 m^2. A large portion of the lower mound is covered by a point bar of the relict Euphrates, but the high mound appears completely.

Tell Al-Jadeda is located near Al-Saadoon village, south of Al-Hammar marsh, about 25 km south of the current Euphrates River, and about 9 km east of Tell Jebarah. The approximate area of the tell is 700 m^2. Situated directly above the relict course of the Euphrates, archaeological remains appear scattered over the tell surface. It is transected by an industrial canal that was used to drain water from the marsh.

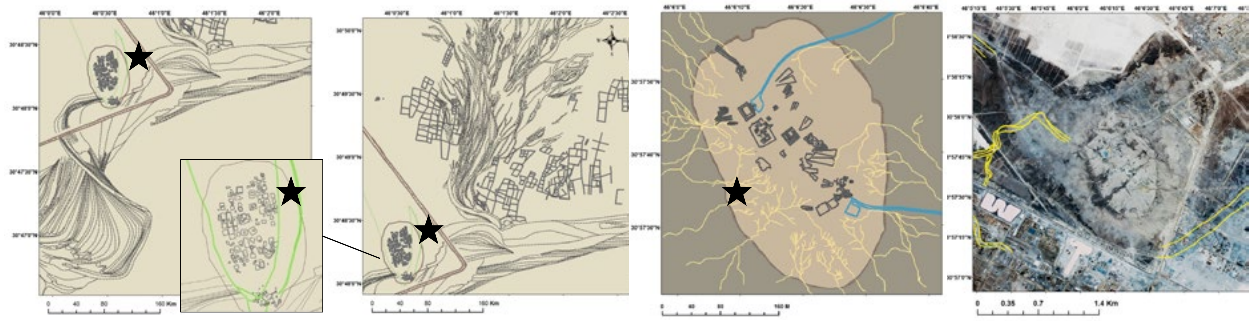
Tell Bint Al-Saeigh (Abu Thahab) is located in the Al-Maleh marshlands south of Al-Hammar marsh, about 30 km east of Kisiga and 23 km south of the current Euphrates River. The overall site encompasses approximately 30 ha (Hamdani 2014: 15) while the approximate area of the main mound is 320 m^2. It is situated near one of the river channels that branched from the relict course of Euphrates. A few architectural remains appear on the surface, but the tell was transected by a drainage canal that has distorted most archaeological features.

Tell Jerbasi is a cluster of archaeological mounds located in the Jerbasi marshlands at the southern edge of Al-Hammar marsh, about 21 km south of the current course of the Euphrates River. The approximate area of the circular central tell is about 476 m^2. Archaeological remains are noted at the surface, as well as many narrow drainage channels that surround the Tell and extend in parallel to connect with the ancient river course.

Bit Iakin (*Tell Abu Salabikh-in-Basra).* The 44 ha site, tentatively identified by Georges Roux as Bit Iakin, the 1st millennium BCE Chaldean capitol, comprises a large lower mound surmounted by a walled upper mound of about 268 m^2. The site is located in Abu Salabikh township, about 21 km south of the current Euphrates River, adjacent to the same relict course that passes by the previous sites. Architectural remains are visible only on the upper mound. Large, relict agricultural areas extend eastward from the site, covering over 4000 ha (Hritz and Pournelle 2015).

Dating relict channels of the lower euphrates

As can be seen at Figure 16.11, there is more than a casual association between each of these sites and the recently exposed relict riverbeds. Most are situated either at a stable node in the turning point of a meander

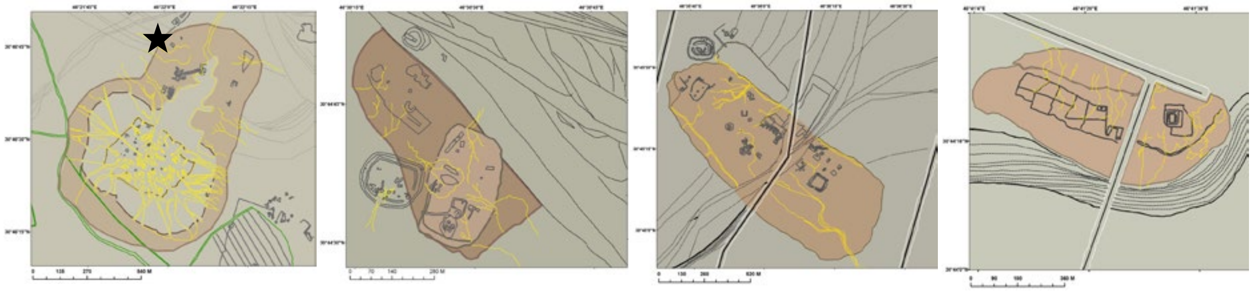


16.11.1 Eridu (Tell Abu Shahrain)

16.11.2 Crevasse Splays

16.11.3 Ur (Tell al-Muqqayar)

16.11.3 Ur (Quickbird^{TM})

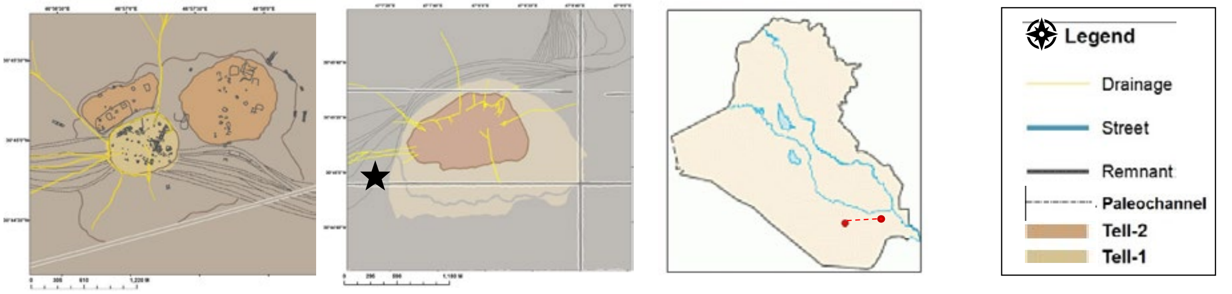


16.11.4 Kissiga (Tell al-Lahm)

16.11.6 Tell Jebarah

16.11.7 Tell al-Jadeda

16.11.8 Tell Bint al-Saeigh



16.11.9 Tell Jerbasi

16.11.10 Bit Iakin (Tell Abu Salabikh)

Locations

Figure 16.11. 3rd–2nd millennium BCE sites on the relict Lower Euphrates. Stars indicate sample points. (Figure: Nagham Darweesh Al-Hawi 2017).

scroll, or wrapped in a river bend. As noted by Roux, at Bit Yakin, a walled channel leads from the riverbed into the mound, leaving no doubt of the direct association between these features. Therefore, insofar as can be determined by site association, we would broadly date this system as 3rd–1st millennium BCE, with the weight of evidence pointing to the 2nd millennium BCE. For refinement of this estimate, we turn to absolute dating evidence (Table 16.1).

In consideration of sediment dates, several samples provide broad brackets. All near-surface samples date to the 1st millennium CE, consistent with inundation and marsh formation during Islamic Periods. The deeper (3–5 m) soundings at Rumayla and Hareer show marshy sediments dating to the 5th–6th millennia BCE. Fleshing out this picture, travelling west to east, shell species and dates trend through time from shallow marine, through estuarine, to brackish and fresh-water-dwelling, consistent with a prograding delta. Notably, at Chubayish and Hareer, away from the charted channels, both sediments and their associated malacofauna are marshy, not fluvial. By the 1st millennium BCE, Persian conch shells widely scattered near Khayabir (Charax Spasinou) indicate close proximity of the Gulf — a location consistent with that reconstructed by Gasche based on Classical accounts, Al-Hawi based on GIS modelling, and by Abdalrazak based on sedimentary biofaces (Abdalrazak, Albadran, and Pournelle 2017; Al-Hawi 2017; Gasche 2004). Meanwhile, samples taken directly from fluvial sediments consolidated in point bars within meander scrolls are consistent with the archaeological evidence. Those from the older bars to the west of Bit Iakin date to the 4th–3rd millennium; those from the youngest point bar in the scroll to the 1st. Rumayla samples R13–14 show 3rd millennium BCE fluvial sediments. Results from T. Lahm are complicated by lack of clear association between sample points and geological features, but both pottery scatters and OSL ages are consistent with 3rd–1st millennium occupation.

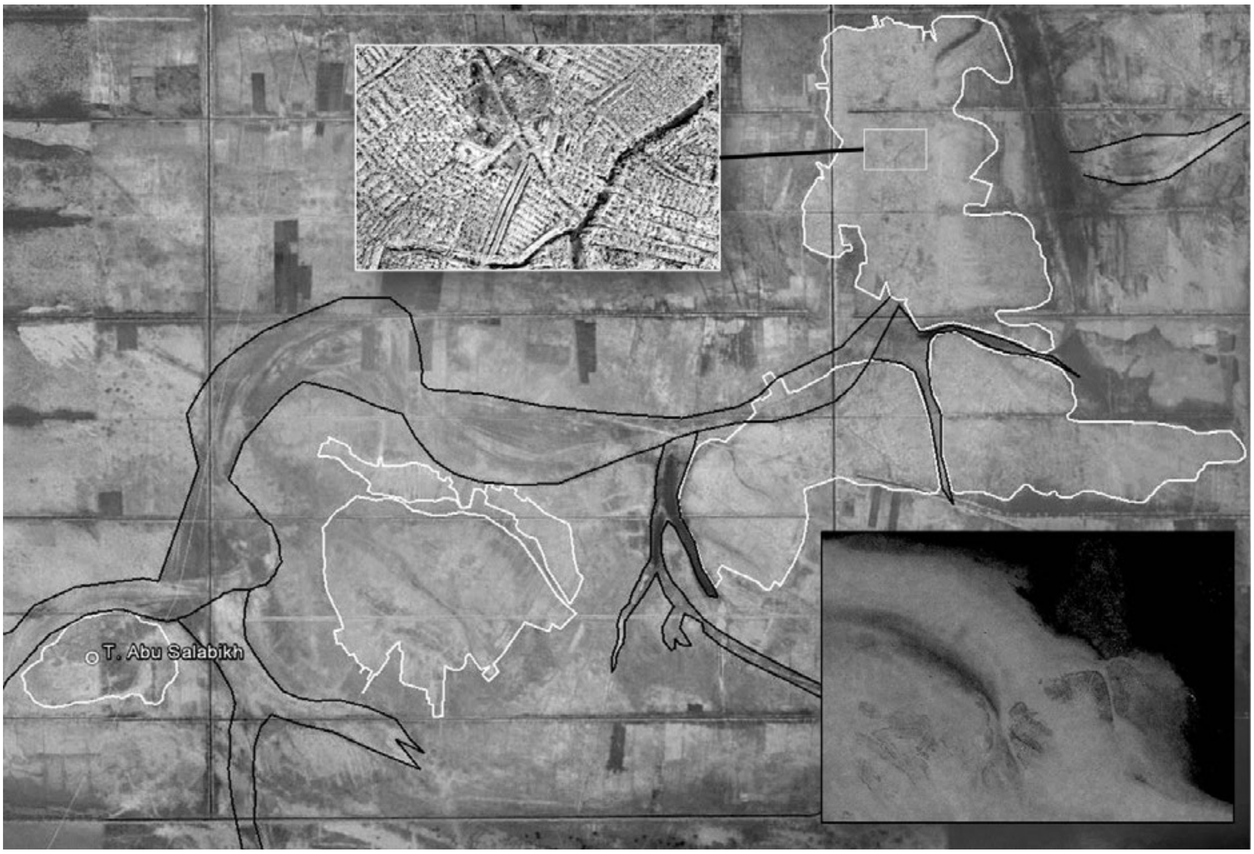


Figure 16.12. Intensive cultivation on the Lower Mesopotamian alluvium. The remains of 4000 hectares of palm gardens (white outlines; inset) are visible as vegetation marks to the east of Bit Iakin (T. Abu Salabikh-in-Basra, bottom left) sprawl between avulsive splays along a relict course of the Lower Euphrates. Subject to periodic inundation (inset, bottom right), soils are flushed by annual floods. This area, covered by marshes since Abbasid times (1st millennium CE), was drained in 2003. Protected by a thick silt-and-shell cap, it has not undergone deflation. Therefore, surface ceramic survey is possible only on the tops of mounds disturbed by recent plowing or grave-digging. Nevertheless, Georges Roux, who visited the site in 1958, reported ceramics dating to the 3rd millennium, and given that only the topmost portion of the mound protruded from the lake, asserted the likelihood of much older occupation (Roux 1960: 22) — a view shared by local antiquities inspectors. Base Image: Digital Globe 2010 courtesy Google Earth. Inset: CORONA 1968.

Were this merely a mapping-and-dating exercise, our results might be of only minor geological interest. Nevertheless, the result of that exercise *is* of real importance, on two counts. Firstly, in this context we *cannot* account for channel diversion as the result of human manipulation of sediment deposition ancillary to levee-top irrigation schemes — for the simple reason that, along this quite visible channel system, despite its obvious existence, there *are no* levees of any substance. Here, channel sinuosity is influenced by the local North Rumalia, Ratawi, and Al-Zubair anticlines (upfolds). Where these folds intrude, ever so slightly, into the plain, they tend to divert water around them. On encountering the subsurface rises, water slows and spreads, forming multiple channels through local topography, so that between these folds fall the multiple crevasse splays characteristic of the Hammar basin (Figure 16.13). In this setting, archaeological sites are scattered across the very slightly higher ground among the channels (Figure 16.9).

Under such a hydrologic regime, in contrast to levee-based, gravity-fed 'herringbone' irrigation systems characteristic of the middle alluvium (Figure 16.2) (Wilkinson, Rayne, and Jotheri 2014), intensive cultivation here comprises organic sprawls of palm gardens between the splays (Figure 16.12) (Hritz and Pournelle 2015). On the middle alluvium, as deposited sediments reduced gravity flow, irrigation systems were abandoned, then re-engineered. Head works maintained water levels, but were subject to flood damage. Without adequate drainage or fallow, intensive irrigation resulted in soil salinisation, until they were abandoned to wind erosion. The enduring struggle was that of bringing water back from where it wandered.

But on the lower alluvium lands were subject to periodic inundation by both rivers. Soils were flushed by annual floods. Spring grasses and emerging reeds enticed flocks up to the edges of the marshes, where they could graze through dryer seasons. Palm gardens

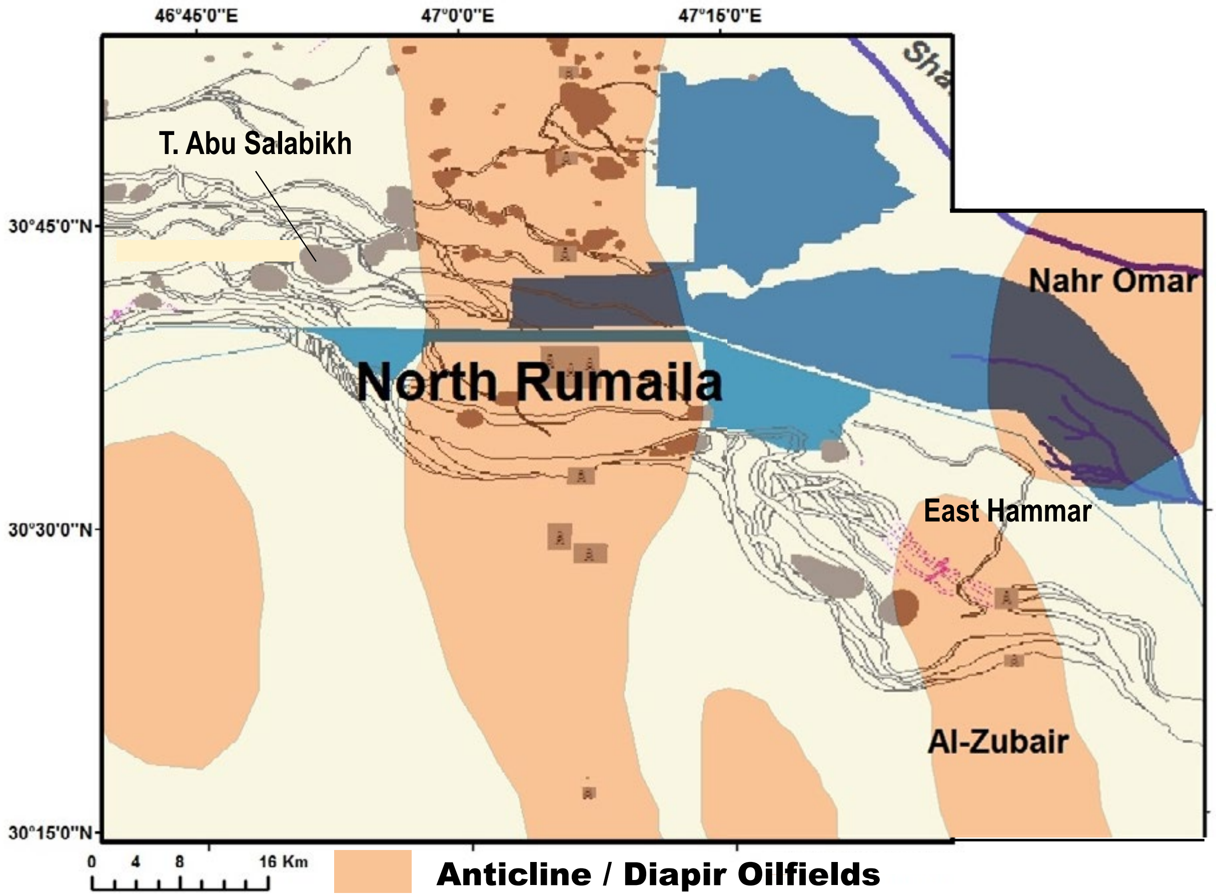


Figure 16.13. Abu-Salabikh (L) and East Hammar (R) crevasse splays, associated with the North Rumalia, Ratawi, and Al-Zubair anticlines (upfolds). On encountering the subsurface rises, water slows and spreads, forming multiple channels through local topography. Archaeological sites are scattered across the very slightly higher ground among the channels. Stars indicate our sample points. (Figure: Al-Hawi 2017).

could spread for miles, crops maturing beneath their canopies (Pournelle and Algaze 2015). Moving back in time and westward in space, it is these conditions — similarly influenced by equivalent folds and diapirs associated with the oil fields around Rumayla — that are most analogous to those of the Lower Euphrates between Uruk and Kisiga during the 4th millennium. For, no matter where the twin-rivers wandered on route, this was where they always ended.

To get at behavioral dynamics behind activities on the upper alluvium, Wilkinson spearheaded an agent-based modelling project that investigated dynamic regional conditions and coping mechanisms that allowed some settlements to persist through extreme climatic events (Wilkinson *et al.* 2007). Using geospatial and archaeological survey data as model variables (climate, soils, disease, conflict, labour availably, kin networks, transport systems, perception of risk, swarms of locusts etc.) (Wilkinson *et al.* 2013: 255), the work established tolerance thresholds that, once exceeded, were likely to trigger emigration. For example, simulations of a five-year drought revealed the non-linear and complex responses of communities. In this scenario, growth and expansion of exchanges between community members illustrated pathways in which an environmental impact can translate into an economic impact, and how economic impacts can be absorbed and mediated via social networks (Wilkinson *et al.* 2013: 257). The project demonstrated the complexity of ancient societies, and the flexibility and resiliency of their communities in times of social and environmental stress (Wilkinson *et al.* 2007; 2013).

If, as this model suggests, community stressor tolerance levels in the upper alluvium were exceeded, and emigration was triggered, the question remains: to where? Co-author Pournelle's hypothesis: southeastwards, following the marshy edges of the prograding delta, (Pournelle 2003; 2013), is now testable — in numerable ways.

Nota bene toward future research

In the long history of interdisciplinary work in the Middle East, beginning with the Braidwoods, systematic application of innovative scientific methods developed by environmental sciences in order to understand socio-ecological systems has been rare — but always transformative. Wilkinson and others envisioned bridging qualitative data gleaned from ancient history (as described by Breasted on the University of Chicago Oriental Institute's foundation in 1929), with quantitative data collected from the natural world, in order to truly understand the legacy of coupled human-environmental systems embedded in the Mesopotamian landscape. With increasing access to the region, new synthesis of old datasets, and emergence of new tools and methods, it is becoming possible to answer long-standing questions and test previous models. These new tools, methods and approaches provide potential for applications of the long history of adaption, collapse and resilience of the Mesopotamian socio-environmental system to developing solutions to today's (and future) real-world problems.

The Braidwoods showed the critical importance of applied palaeofaunal, palaeobotanical, and other studies that became part of the standard archaeological toolkit. Since then, a variety of radiochemical dating methods have been introduced and also become expected (even if still difficult and expensive in practice). But we face profound new challenges in this alkaline, waterlogged, sedimentary context that require new foci for palaeobotany and zooarcheology. Practices drawn from terrestrial and marine sedimentology now must be consistently addressed: microfossil analyses of (plant) phytoliths, (fish) otoliths, ostracods, foraminifera, and diatoms, in addition to pollen Archaeological biogeochemistry can (and must) be used to delineate agricultural and other activity zones and boundaries. We have pointed herein to the past dearth of good old-fashioned sedimentology, but also to new opportunities from the field of geology, such as micro-tectonics, especially germane to these contexts. A 'reboot' of collaboration with these traditional disciplines will help us identify those forces of nature that have always been beyond human control, but within human capacity to respond, and that should be included as variables to run new socio-environmental models such as the agent-based models that Wilkinson once pioneered. Heyvaert (2013) nicely summarises the suite of tools now available in this new context.

Efforts to date have demonstrated the utility of new tools and methods. For the Euphrates system, we begin to see a picture of large branches of the Euphrates dominating the entire alluvium and setting the stage for the uninterrupted cycle of settlement and marsh expansion, coastal port development, irrigation intensification and extensification and retraction staring us in the face from Uruk to Basra. The interaction of the rivers and their major branches around the Shatt al-Gharraf provides the underlying ecological and landscape conditions for the emergence and continued spatial shifting of Uruk-in-birdsfoot type settlements and reconstructed channel systems (Pournelle 2003a; Figure 16.8), and freshwater marsh surrounds and origins (Hritz, Pournelle, and Smith 201; Pournelle 2003a; 2003b; 2007; 2012). The results of this image analysis have now been validated and extended by extensive geoarchaelogical investigation by contributors to this volume (Jothari, Altaweel, *et al.* 2017)[8] with the promise of ever more robust contributions and clarifying data with future fieldwork. To this end, understanding the evolution of the Euphrates river system, its major branches and smaller-scale channels, and linking these features to cultural landscape artifacts and ecofacts by spatial location, methods outlined by Wilkinson, has already demonstrated the complexity of the social and environmental systems over time. Future work has the promise to identify the components of these socio-environmental systems by systematic integration of field data collection, analysis remote datasets and re-analysis of past datasets. From the recent work discussed in this chapter, we have shown the base line data and methods to address key long-standing questions of Mesopotamian history. Such as what was the process by which largely natural branching canals became artificial channels, what is the role of the Euphrates south of the Shatt-al Gharraf, what part

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[8] Although in that publication, the authors mischaracterise Pournelle's explicit argument, limiting it to a footnote on marine incursion: 'Different locations for the point of maximum transgression have been posited:... Hritz and Pournelle (2015) suggest Samawah.' Nowhere in Hritz and Pournelle 2015 did we suggest that 'the sea reached Samawa,' and having personally discussed that issue with coauthors Jotheri and Rost on several occasions prior to 2017, find the misattribution puzzling. What Pournelle did say was that, based on sedimentological and malacofaunal evidence, a shallow brackish marine layer was detected by Aqrawi (2001) in two well sections east of Uruk, RC dated to 3600 BCE–5600 BCE at -6 to -10.5m depth, transitioning to brackish marsh at -2.5 to -5m depth 2000 BCE–3300 BCE, indicating that Ur (not Uruk), was, at incept, an estuarine coastal port (Hritz *et al.* 2012). This hypothesis, detailed in Pournelle 2003, is strengthened by the further evidence presented herein, as well as by subsequent work at nearby Tell Abu Tbeirah (Jotheri 2017). We can only presume that the lead author glanced at the one small-scale figure included for reference (for the non-specialist readership of that conference volume), and misconstrued the broadly shaded zone of millennia-long marine *influence* (such as tidal push of fresh water, spawning migration zones, inter-fingering estuarine mixing zones, etc.) as a Gulf shoreline for any given period. Unfortunately, this presumption misrepresents the actual argument presented in that text, and ignores (or misunderstands) the entirety of several chapters-long, widely circulated, specialist discussions that directly address Uruk's surrounding inner (freshwater) delta and marshlands (which they do not reference). By 2001, following multiple lines of evidence and long discussions with Wilkinson (including corings conducted at Uruk by the German Archaeological Institute), Pournelle had already hypothesised and presented internationally the marshland font of bioresource availability and site interconnectivity as underpinning 'The Sumerian Takeoff' (Algaze 2001: fig. 1; 2005; Pournelle 2003a; 2003b; 2007; 2012).

does it play in the formation of long-standing, seasonal and ephemeral marshes over time, how does the delta of the rivers impact the evolution of the ecological and resources landscape over time, and how do these processes play out in the changing social, political and economic systems of Mesopotamia? As we have shown above, these questions can be addressed from an integrative data approach.

For understanding the natural and cultural history of Tigris River system, recent fieldwork and imagery analysis has demonstrated the importance of the Shatt al-Gharraf to shaping the settlement and environmental landscape of Sumer. For example, the previous arguments that 'no sites' existed east of the Shatt al-Gharraf prior to the Islamic Period is incorrect. Historic excavations at Girsu show evidence of Ubaid Period settlement. The Atlas of Iraqi Archaeology documents hundreds of early sites east of the Shatt al-Gharraf and recent excavations at Nina by Nadali and Polcarno (2016; 2018) leave no doubt that Ningin, at the end of that chain, was already a major site during the late 4th millennium BCE (Ubaid 4).

There are a number of other at least 3rd millennium BCE sites along the remnant of the ancient Gharraf levee. If we assume that these sites are sitting at the edge of the levee and away from the crest, then we can assume a rather large Tigris branch in this bed. Future work should begin by using them as a guide to start a programme of systematic coring to determine sedimentation rates and potential of buried features. Such work has already begun in the environs of Ningin, and is scheduled to begin around Lagash next year. Hritz (in press) proposes a delta of Tigris and Euphrates branches in the area of Qalat Sukar with branches of both rivers intermixing in this area and splaying outward to feed cities such as Girsu and Lagash. This configuration of both river channels in the area would have made possible sites like Girsu to withstand unpredictable water flows by providing diversified sources of water, beginning to address the long standing question of resilience of different cities and systems within Southern Mesopotamia. Various efforts to map and locate sites in the marshes have been ongoing since 2003, and will prove crucial to understanding southern Sumer. Lack of publication of these materials and ongoing and continuous looting make it difficult to properly contextualise the impact of this data.

New tools and methods for integrating archaeological and textual datasets has the potential to reveal cross-sections of the Mesopotamian socio-environmental system such as integrating data from different environments, different social strata; different activities, and use of different resources. For example, Rost's (2017) recent efforts to reconstruct water management in Mesopotamia from the 6th–3rd millennia BCE. makes use of nuanced analysis of the texts and can be enhanced with the integration of topography and geomorphological data through the use of spatial tools such as GIS to anchor textual data with topography. Collaborative data sharing between archaeologists, historians and language specialists allow us to address complex questions with new tools and aligned analysis. As fieldwork and new datasets are collected, we should strive for transparency, preservation and reproducibility that means targeted and problem driven research.

Desideratum: New Cartography. As noted earlier, new methods for landscape sensitive cartography and attention to the micro-topography (including nuanced attention to soil types, land cover, and features) of the Mesopotamian plains provide an approach and framing that contextualises the historical record, and renders the method of simple black lines (maybe with a bit of shading) on white maps, no longer sufficient. Multidisciplinary tools and methods, such as those used so importantly and widely by Wilkinson, provide a common language for communication across Mesopotamian scholarship and allow this scholarship to reach a broader audience. These tools allow us to re-think conventions developed before such representations were possible. This does not mean merely aping the GIS conventions of other disciplines. We need our own. We need to work with cartographers to develop a new visual language appropriate to the complexities of both Mesopotamia and our interconnecting fields.

Conclusions

Wilkinson's intellectual legacy in understanding the evolution of the rivers that built the Mesopotamian delta is profound. At the level of geoarchaeological tradecraft, against assertions that irrigation 'caused' river diversions, he demanded careful examination of the role of underlying gradients and bed load in establishing channel morphology. Against a 'connect the dots' approach that presumptively strung sites along imagined channels, he insisted on due diligence in examining topology and topography to establish the physical possibility of such reconstructions. Against presumptive dating of relict channels by their mere proximity to visible archaeological sites, he encouraged care in understanding how the duelling taphonomic processes of burial and exposure made remote sensing of such 'associations' a technical challenge. Against conjecture regarding 'how deeply buried' sites might be on the upper alluvium or along the Zagros, he pointed to the counter problems of 'how deeply exposed' and 'how high pedestalled' they might be elsewhere.

By use of such techniques, Wilkinson (and his students, and now their students) defined inherent characteristics of what he termed resilient versus fragile landscapes in arid environments, and how these varied through space and time. Throughout Syro-Anatolia, where rain-fed agriculture and pasturage was the norm, enhancement and preservation of soil moisture was essential to long-term resilience of agricultural systems. Those that pushed agricultural extraction to the very limits of productive capacity teetered at the brink of drought with the slightest climate fluctuation. In the Akkadian upper alluvium, where river waters debouched with strongest force onto the plain and built fine levees, irrigated fields produced three crops per year — so long as headworks were maintained and survived annual floods. If not, rivers burst through levee cuts and turned field systems into reed swamp pasturage, or diverted rivers into entirely new beds, leaving their cities dry. But the vast Sumerian and 'Sealand' wetlands (both riparian and marsh) of the lower alluvium were, until very recent times, most resilient of all — as had been the upper alluvium, before those levees formed. There, the inevitable (if largely unregulated) supply of water made possible intensive garden cultivation of dates, crops, and reeds in garden systems that were, within broad limits, tolerant of fluctuations in salinity and seasonal water supply. Where it might be said that, rather than people making splays, splays made people: a fact reflected in repeated, brutal politics of acquisition from (according to legend) Gilgamesh, though Sargon, Sargon II, his son Sennechrib, Alexander and his Seleucid successors, and on to Saddam.

This is far from ecological determinism. Quite the contrary: by reintroducing to the discussion the geomorphologic externalities of human interaction with the hydrosphere and lithosphere, Wilkinson reintroduced human agency as an inherent component of the ecological system. Where others saw the technological conquest of nature through political and managerial control of nature as a success, and the collapse of technocracy as collapse and failure leading to depopulation, Wilkinson saw overextension of resource extraction as a primary mechanism creating fragile ecological systems. Agricultural ecologies that maintained ecological robustness enabled urban nucleation and resilience. Those that created fragile systems inevitably resulted in denucleation and migration to more hospitable environments — such as the wetland margins of the southern alluvium.

Specifically, the integration of the fundamental techniques Wilkinson developed, re-analysis and synthesis of existing datasets, and new tools for dating and analysis, have allowed us to begin to reconstruct the riverine and settlement system as a whole and provide direction for future archaeological field work as ground conditions enable it.

In this lengthy overview — yet all too brief, given the scope of related issues on Wilkinson mentored his colleagues young and old — we highlight four outcomes of his productive mentorship: (1) Updates to techniques and applications required for this new (to ME archaeologists) environment; (2) Updates to the evolutionary model of the alluvial Euphrates from the 4th millennium BCE onward; (3) Multi-proxy evidence for the location of a Tigris River; and (4) A new generation of research questions and fieldwork.

Since the turn of this millennium, our investigations of the Lower Mesopotamian alluvium have taken us from high earth orbit to shallow (by geological standards) earth coring; from macroscopic terrain modelling to microscopic particle analyses. In that time, only a few archaeologists have shared the privilege of visiting the undeflated, silt-capped precincts of southeastern Iraq, but our impressions thereof are unanimous: we confront there an utterly new set of challenges, beginning with the taphonomic. Given the lack of surface deflation, archaeological surface survey there *must* include geophysical survey and shovel-testing. And, to be effective in these circumstances, geophysical methods *must* be imported from other deltaic wetland contexts, where prospection in waterlogged soils is well-understood, and then adapted to cope with the massive overburden of multiple occupation levels lurking beneath the crusts. Pioneering work by Jörg Fassbinder at Uruk shows that this is, indeed, possible — but never easy, and *always* must be supplemented by coring or auguring.

But before such work can even begin in earnest, at the risk of stating the obvious, we need to understand what we are looking for, and what remains there may be. In the southeast, this *requires* an anthropological as well as a humanistic approach; an approach well informed by both ethnoarchaeology and a new range of textual analyses. The point of the former being, not to project an image of the recent past onto the remote past, but rather to fully understand ways in which this unique environment may have been used and manipulated — ways that are for the most part unimaginable for those whose lifelong experience has been in arid deserts or Eurasian farm- and steppe-lands. The point of the latter being: to move away from targeted iterations of grain stores, livestock production, and roadways most easily imagined by the same.

Ranging from the upper alluvium around Tell Abu Salabikh, and moving through time to the lower alluvium around Tell Abu Salabikh-in-Basra, we can now see that during the times of transition from whatever came before to the earliest state systems, and wherever that occurred, the Euphrates was not a singular, consolidated channel boasting well-developed, cultivable *bunds.* Intensively cultivated Ur III levees with their signature herringbone field systems came later. The landscape manipulated by those earlier folk would have featured intensifying marshland extraction, recessional cultivation, and multi-canopy gardening. In its furthest southeastern reaches, only very recently indeed has the Euphrates been forced to abide in a unitary bed — and even there, even now, levee-top grain cultivation is a relatively minor, patchwork addition to the range of everyday agricultural and horticultural activities (that feed a burgeoning population on the margins of what marshlands remain).

Likewise to this day, possession of these productive lands is hard-fought among a triangle of local actors, absentee landlords, and various (and competing) religious and state institutions. Thus, while Euphrates-based irrigation often was one, it was only ever one, of the wetland-based agri- and aqua-cultural strategies nurtured, maintained, and exploited by resilient local actors. This suggests that marshlands were not *refuges* from 'the' state: they were loci of *competing* states with their own organisational logic.

Multi-proxy evidence for the location of a portion of the Tigris River opens new opportunities to test this model. During the formative period between the 5th millennium BCE to the 3rd millennium BCE, it flowed from the Diyala river basin and formed an early Shatt al-Gharraf (Hritz in press). Coupled to a new database of archaeological sites identified via remote sensing, this provides a framework to link complex models of shifting ecological niches described in the margins of the marshes, with systematic on the ground fieldwork (such as surface survey of areas outside the narrow belt of central alluvial plains). Such integrated assessments begin to weave together once disparate and localised reconstructions of Mesopotamian settlement patterns to include once 'empty' areas of the Mesopotamian plains Using these methods, the Mesopotamian archaeological, environmental and historic record can shed light on how communities have adapted or maladapted to sets of changing conditions over time, the role of successful and unsuccessful technological solutions, and how socio-political systems change. For example, Girsu survives and thrives much longer than its neighbours, likely due to a combination of specify ecological diversity in southern Sumer, the opportune conditions of branches of the Tigris and Euphrates in the area thus spreading risk and allowing reliance on two different river systems, and adaptable socio-political conditions able to absorb small-scale perturbations of the socio-environmental system. From examples such as Girsu and others, we can say that successful adaptation is relative with some cities surviving hundreds of years beyond others, due to specific ecological diversity. But even Girsu ultimately collapses, why? What confluence of conditions is needed for a site, a landscape, a society to become no longer sustainable and resilient? These questions move Mesopotamian archaeology into new places of scholarship and contributions to broader research questions.

Our move away from a narrowed focus on aggressive (irrigation) engineering, toward and expanded focus on bio-productive wetland cultivation and husbandry, begs a number of questions. Which ecosystem services were, in fact, essential to state-making and urban resilience — and when. Which are recurring, and especially salient now? By changing level of analysis from individual, localised contexts and actors, to that of an integrated alluvial system, can we better understand cycles of war and peace as epiphenomena driven by resilience in the face of climate change events? To what extent was 'globalisation' of trade in a range of goods, from elite preciosities to commodified staples, dependent upon and connected to multiple sources of bioproductivity? How did the environmental constraints imposed by evolving river systems promote and/or limit of population aggregation? After two decades following Tony's footsteps, we've only just begun to work though those implications.

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Subsistence Stability in Irrigating Societies: A Diachronic Perspective from the Jordan Valley

Eva Kaptijn

Introduction

Irrigation is vital in many areas of the Near East. This is the case today as it was in the past. For several millennia people have attempted to increase crop yields and bring arid areas under cultivation by means of irrigation. The creation of irrigation systems has a major impact on the landscape as well as society, and often continues to influence people's use of the landscape for many centuries. Irrigation is therefore an important aspect of Near Eastern archaeology and especially of landscape archaeology. Tony Wilkinson conducted groundbreaking research on irrigation in combination with landscape archaeology. His writings and personal guidance have greatly influenced the author and I am therefore delighted and honoured to be able to make a contribution to the present volume.

To understand the influence irrigation had on past societies it is important to understand the workings of the irrigation system, not only on a general level but also with respect to how it affected the day-to-day life of the farmers, as that is the level at which most decisions were made. It is, therefore, important to identify the timing of potential water stress as well as the extent of this stress. The way people were able to cope with stress is determined by the organisation of subsistence and society and will to a large extent have influenced the stability of their society. In this article three different societies from three different time periods, but all using the same irrigation system, will be compared in order to elucidate the effects of mode of subsistence, socioeconomic, and sociopolitical organisation on the potential of the irrigation system and the stability of society.

Inhabiting arid environments

The practice of irrigation brings enormous advantages and possibilities to people in arid environments. First and foremost, it allows regions that lie outside the boundaries of dry farming to be inhabited (Wilkinson 2003: 45; Wirth 1971: 92). Second, irrigation buffers against short-term or regional fluctuations in precipitation and climate. And third, agricultural productivity greatly increases as the high temperatures make intensive farming with relatively short growing seasons possible. However, with these advantages come several drawbacks. One important problem is that systems usually cannot cope with long or severe periods of drought. Furthermore, irrigation infrastructure is vulnerable to climatic or environmental events, like major floods or earthquakes. Additionally, leaching by irrigation water and intensive agriculture mean there is a high risk of soil depletion, and increased sedentism and population density induce depletion of local resources, such as wild animals or plants (Nelson *et al.* 2010: 4–5). Moreover, stable sociopolitical circumstances are needed for an irrigation system to function satisfactorily. Especially in a system of canal irrigation based on gravity where a large area is dependent on a single canal, organisation of water use is essential. This organisation can, of course, take many different forms, from regulation by a central authority or shared decisions by all involved parties (Mabry 1996). However, it is important that no conflicts arise that might disrupt water distribution (Scarborough 2003: 3).

There are several aspects that increase the stability of a society and its capacity to overcome potential problems in the irrigation system. Firstly, diversification of subsistence is important. When a society does not rely solely on intensive irrigation agriculture, but also incorporates forms of animal husbandry and hunting, it is less vulnerable to shortcomings in the irrigation system. The same applies to regional diversity. If different landscape units or environmental zones are incorporated in the subsistence base, climatic or environmental changes might be less severe as these often affect zones differently (Algaze 2001: 200), for example, the wide range of local environments exploited by the Zuni in the North American Southwest (Nelson *et al.* 2010: 12). Furthermore, inter-regional connectedness and trade can counteract food shortages by the relocation of necessary supplies, e.g., the Hohokam ballcourt network (Nelson *et al.* 2010: 17). Similarly, intensive food storage can provide relief with regard to short-term shortages, such as Mamluk central grain storage (Walker 2006: 82).

The zerqa triangle: cycles of settlement

Its location at 200 m below sea level, the high temperatures, and limited rainfall (see Figure 17.1) make the Zerqa Triangle, located in the central Jordan Valley (Figure 17.2), a steppe region where successful

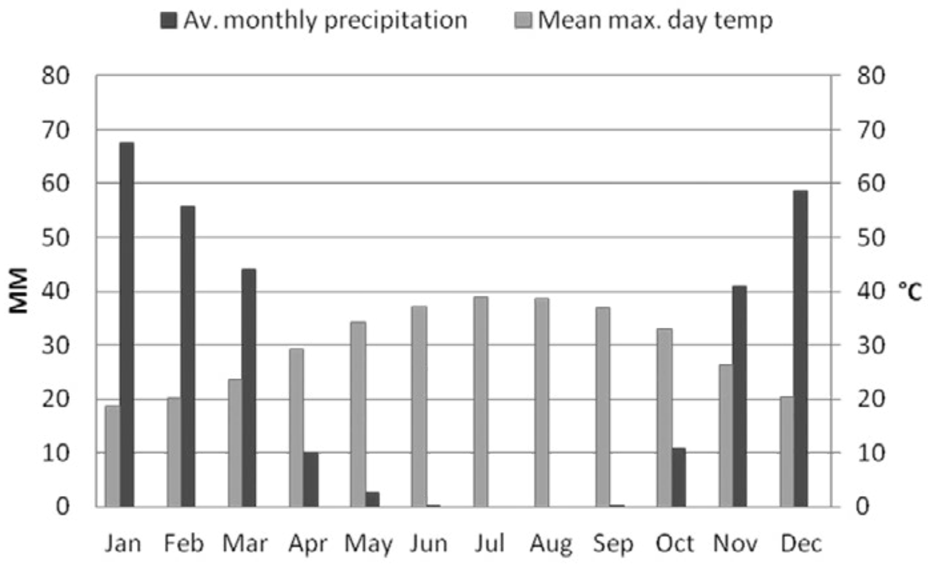

Figure 17.1. Average temperature and precipitation at Deir ʿAlla (average of period 1976–2005).

dry farming over a prolonged period of time is not possible. Nevertheless, the region witnessed repeated periods of intensive habitation lasting several centuries (see Table 17.1). Besides the multi-period tell sites that dot the landscape of this region, the intensive survey of the 'Settling the Steppe' project has identified several unobtrusive artifact scatters representing isolated farms as well as large villages and villas (Kaptijn 2009). Periods of intensive habitation are not followed by complete abandonment, but by less dense occupation or archaeologically poorly visible habitation (Kaptijn 2009: 197–201, 259–261, 291–295). Recent excavations are uncovering remains from periods until now only known by a few sherds, e.g., Abbasid remains at Tell Abu Sarbut (Steiner 2014). Therefore, complete abandonment probably did not occur in any of the periods.

In order to maintain a society that is sufficiently successful to survive for several centuries, communities must have found a way to overcome not only the long and dry summer, but also the exceptionally dry years that occur every few years. The modern climate is characterised by a high inter-annual variability in precipitation: every three to five years the region experiences a year with total precipitation far below average (Ashbel 1945; Nedeco 1969a, table B-4; Jordan Meteorological Department[1]). Although the past climate cannot be equated with the present-day climate and several fluctuations have occurred, palaeoclimatic proxy data do not show changes in climate during the last four millennia of such a magnitude that irrigation would not have been necessary in this region (Bar-Matthews *et al.* 2003: fig.13; Rosen 2007: 89).

Before circa 2000 BC the climate was wetter and less hot than it is today (Rosen 2007: 100). Moreover, vegetation cover was much denser, resulting in a much more regular and lower intensity stream flow of rivers than is the case today. Rivers likely flooded yearly and in a much less intensive fashion than the flood flows of today (Cordova 2007: 189–190). These differences in environment are reflected in the way people arranged their subsistence. Several small Late Chalcolithic and Early Bronze Age I villages have been discovered, located along rivers or wadis (Kaptijn 2009: 326–337). Geomorphological investigations at several of these sites have revealed overbank deposits interlaid with occupation material (Hourani 2010). Elsewhere in Jordan constructions have been found that were to all likelihood used to keep overflow water on the agricultural fields longer (e.g., Khalil and Eichmann 2006: 145). It is very likely that the same practice was carried out in the Zerqa Triangle.

When the climate became drier, this form of agriculture using floodwater irrigation was no longer tenable. After a period of very limited habitation, somewhere during the Late Bronze Age, a new form of irrigation was used (see below). This irrigation system allowed several phases of intensive habitation. Although the irrigation system was essentially the same in all periods, the socio-economic, political, and cultural character of these periods differed greatly, which resulted not only in a different functioning of the system, but also in different carrying capacity, stability, and vulnerabilities from one period to the next.

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[1] http://met.jometeo.gov.jo

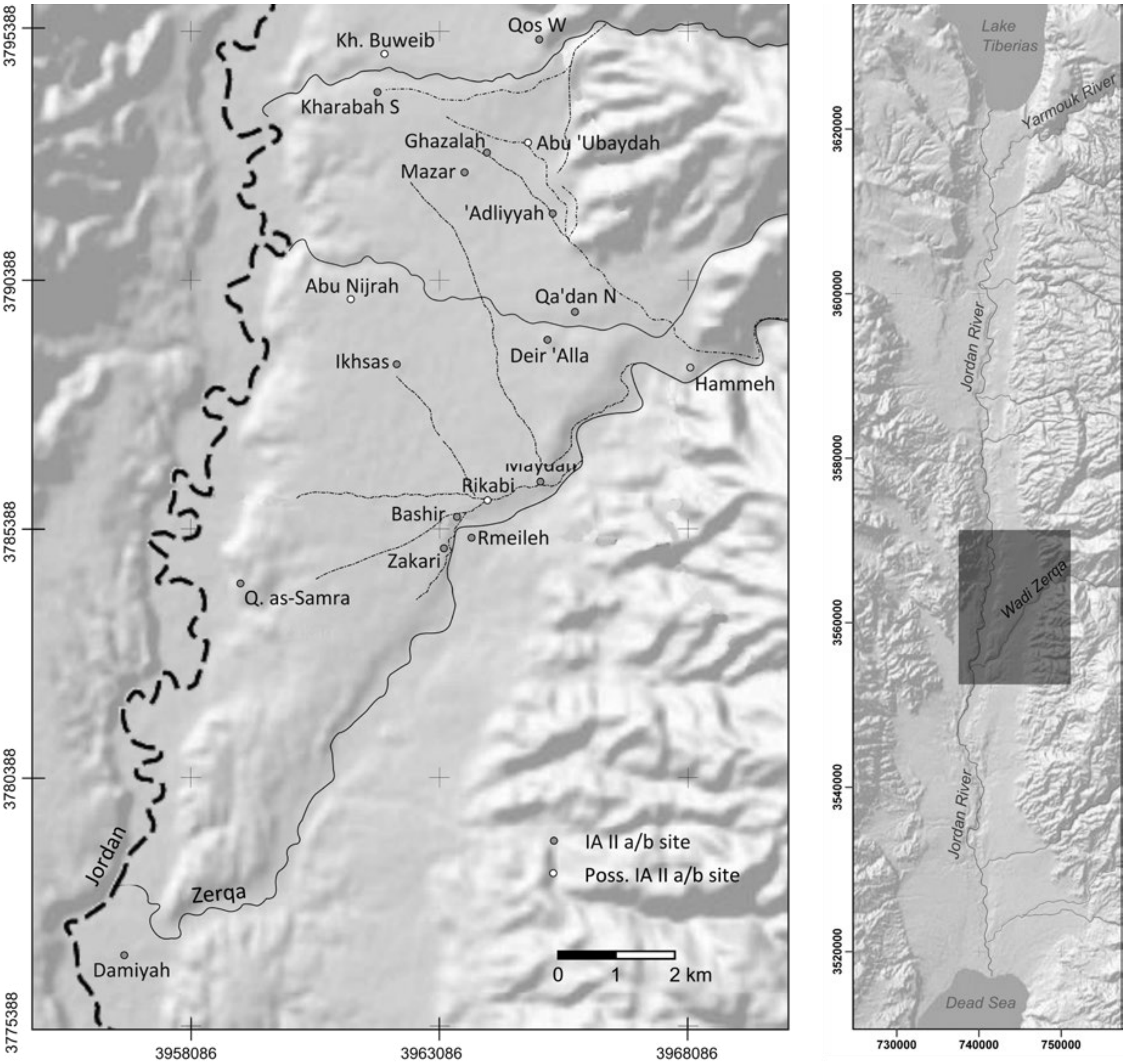

Figure 17.2. Iron Age sites and reconstructed irrigation system (depicted on ESRI shaded relief map).

The irrigation system

The irrigation system in use in the Zerqa Triangle is a form of canal irrigation that takes advantage of the gently sloping terrain to distribute the water of the river Zerqa over the valley plain by means of a network of primary, secondary, and tertiary canals. This system is well documented for the early 20th century when three main canals tapped the river along its upper course and the entire valley plain was reached by canals (see Figure 17.5). In its essential form, i.e., the main primary and secondary canals, the system was the same in the Mamluk Period (Figure 17.4), Byzantine Period, and Late Bronze/Iron Age (Figure 17.2). The physical connection of early modern canals to Mamluk watermills is clear evidence for the continuity of this system. Although no remains of Iron Age canals have been found, the location of settlements and some physical obstructions that the canals would have had to circumvent suggest that during the Iron Age the main canals were in similar, if not the same, locations (Kaptijn 2009: 301–325).

The construction of such a dense network of canals is labour-intensive, even if it is not created as the result of a single preplanned act. The canals have a lasting impact on the landscape (Kaptijn 2015). Once they have fallen into disuse, canals remain visible in the landscape for a long period of time. In the Zerqa Triangle, late 19th-century farmers who were reclaiming land that had been in disuse for at least two centuries stated that they had dug no new canals and that all they had had to do to bring the land under cultivation was to clean out and repair old canals (Merrill 1881: 383). On aerial

Table 17.1. Intensity of habitation in the Zerqa Triangle during the past six millennia.

High habitation density		Low habitation density
Late Chalcolithic/Early Bronze Age (circa 4000–2300 BC)		
		Early Bronze Age IV (2300–2000 BC)
Middle Bronze Age (2000–1550 BC)		
Late Bronze Age/Iron Age (1550-539 BC)		
		Persian/Hellenistic (539–63 BC)
Roman/Byzantine/Umayyad (63 BC–AD 750)		
		Abbasid/Fatimid (AD 750–1170)
Ayyubid/Mamluk (AD 1170–1516)		
		Ottoman (AD 1516–1850)
Late Ottoman/modern (AD 1850-present)		

photographs of the 1940s, the courses of old canals, even secondary and tertiary ones, are clearly visible in areas that had not been reclaimed yet. In several other regions, ancient irrigation canals or qanats have been identified on aerial/satellite imagery or in the field several centuries after these were last used (e.g., Alizadeh and Ur 2007; Wilkinson and Rayne 2010). The longevity of the impact of irrigation on the landscape is probably the principal reason why irrigation systems exhibited only limited change even after prolonged periods of disuse.

It is most likely that the Zerqa Triangle system was first created during the Late Bronze Age. During this period the first settlements appeared in the middle of the plain, where no natural water supply exists, and in the Late Bronze II Period the number of sites rapidly increased (Figure 17.2) (Kaptijn 2014: 28, table 1). Furthermore, botanical studies have shown the presence of crops that require a lot of water, which could never have been supplied by precipitation alone, e.g., large quantities of flax seeds discovered in Iron Age layers of Tell Deir ‘Alla (Kaptijn 2009: table 6.11; Neef 1989; Van Zeist and Heeres 1973: table 1). From that time onwards, this type of irrigation system was used during several periods up to the 1960s (Kaptijn 2009: 301–337). The early development of the system and its continued, albeit intermittent, use lends the irrigation system a time depth of over three millennia. This longevity provides us the opportunity to compare the manner in which the same physical system functioned under different socio-economic structures.[2] Furthermore, the impact of different cropping systems on the carrying capacity of the region can be evaluated, as can the stability of the system and its vulnerabilities.

Between pastoralism and crop cultivation: flexible communities during the Iron Age

Although the irrigation system discussed here was probably initiated during the Late Bronze Age, the focus here will be on the Iron Age, and more specifically on the Iron Age II (1000–539 BC), as this is the period about which we are best informed. Iron Age society in the Zerqa Triangle is characterised by several small tell site settlements (<1 ha) located every few kilometres (Figure 17.2). The excavated settlements (n=7) show that these sites consisted of clusters of houses separated by courtyards and alleyways (Petit 2009; Van der Kooij 2002; Van der Steen 2004: 196; Yassine 1983). Archaeobotanical and archaeozoological remains, as well as related artifacts and settlement organisation, show that the inhabitants practiced subsistence farming supplemented by small-scale craft production and trade (Neef 1989; Van Es n.d.; Van der Kooij 2002; Van der Kooij and Ibrahim 1989; Van Zeist and Heeres 1973). Except for small differences in settlement size, homogeneity seems to have characterised the sites. The distribution of the sites indicates that several sites were fed by the same irrigation canal (see Figure 17.2). The different communities must, therefore, have had a set of shared rules according to which water division was organised.

Subsistence was based on cereal cultivation (wheat and barley) with smaller amounts of pulses (e.g., lentils, grass pea, chick pea, bitter vetch), sesame, flax, and also herbs (e.g., coriander, fenugreek, cumin) and fruits (e.g., grape, fig, olive, pomegranate) (Grootveld 2008b; Kaptijn 2009: table 6.11; Neef 1989: table 2; Van Zeist and Heeres 1973: table 1). Farmers will necessarily have practiced crop rotation, as without it the soil becomes easily depleted. No evidence of intensive

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[2] The Roman/Byzantine/Umayyad Period was also characterised by intensive occupation and agriculture. Unfortunately, apart from the survey data little is available on these periods. New excavations at Tell Abu Sarbut (Mulder, Boertien, and Steiner 2012; 2014) and Tell Damiyah (Petit 2015; Petit and Kafafi 2016) are changing this. However, at the moment insufficient information is available to characterise habitation in these periods.

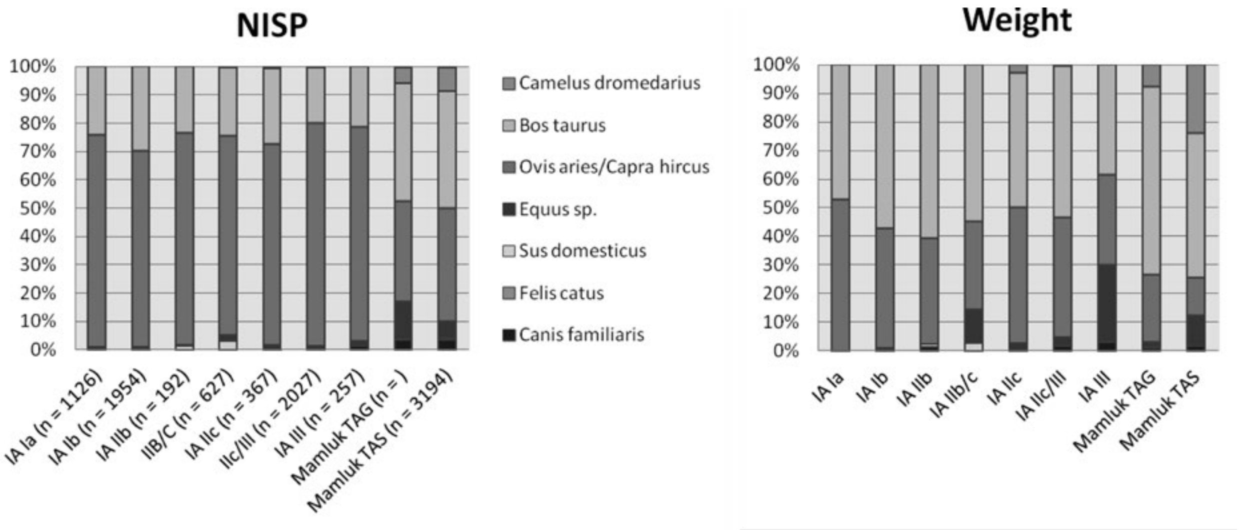

Figure 17.3. Faunal assemblage from Iron Age Tell Deir 'Alla and Mamluk Tell Abu Ghourdan (TAG) and Tell Abu Sarbut (TAS) (adapted from Van Es 1995; 2002; and internal report).

manuring has been attested. This stands in contrast to the Byzantine Period when a dense carpet of sherds was present throughout the valley plain, a phenomenon identified by Wilkinson in Oman (Wilkinson 1982) as the result of manuring with organic refuse and dung collected from the settlement. Irrigation not only made it possible to successfully cultivate crops like wheat, barley, and pulses for a prolonged period of time, but it also accounts for the presence of flax, present at all excavated sites. *Linum usitatissimum* requires abundant water (Allen *et al.* 1998), especially when it is cultivated for its fibers for which there are indications at Deir 'Alla (Boertien 2013: 121, 147–152).

Besides crop cultivation Iron Age villagers also practiced animal husbandry. The faunal assemblage shows that the community relied on domestic animals. Hunting was of minor importance and wild animals never constituted more than a few percent of the total assemblage (Van Es 2002: 265). Sheep/goats formed an important component of the faunal assemblage throughout the Iron Age (Figure 17.3). On average, they form over 70% by NISP and almost 40% by weight (Van Es 2002: 263, table 2a). The second largest group is cattle (circa 25% NISP, circa 50% weight), with other animals only occurring in small numbers (Van Es 2002: 263, 264). The distribution of the slaughtering age shows that cattle was used for meat as well as milk, while during the IA II, the ratio between cows and bulls was as high as 26:7, suggesting milk was an important secondary product (Van Es n.d.). Bone deformation indicates cattle served as draft animals (Van Es n.d.). Sheep and goats were also used for meat, milk, and wool, with males clearly slaughtered at a younger age than females (Van Es n.d.). During the Iron Age II a lot of newborns were killed (18%), which might indicate a food shortage (Van Es n.d.). While cattle were a source of draft animals and will, therefore, have remained near the village and near agricultural fields, the sheep and goats were probably herded in a wider region following the availability of pasture. Until very recently, the movement of herds along the slopes of the eastern plateau, governed by the presence of water and pasture, was common practice (Layne 1994: 38). Iron Age subsistence, therefore, consisted of a combination of (probably migrant) pastoralists and sedentary crop cultivators using cattle for traction and milk.

Characteristic for the excavated sites is the quick and frequent alternation between settlement, abandonment, and resettlement. This phenomenon was first identified at Tell Deir 'Alla, excavated between 1960 and 2009 (Van der Kooij 2001: 295–297), but it has also been attested at other sites in the region (Petit 2009: fig. 15.1). Typically, settlements were inhabited for a few decades after which a period of abandonment followed. The level of continuity between phases of settlement is generally high. Architecture was often very similar (Petit 2009: 229; Van der Kooij 2001), but this can in some cases be explained by the remnants of walls that were still visible after a few decades of abandonment. Furthermore, the pottery shows a clear continuity in both morphology and production technology (Groot 2011: 249). Two examples of local pottery unique to this region, i.e., the so-called 'mansaf' bowl and Franken's type 3 cooking pot, persist throughout the entire Iron Age, for circa 700 years (Groot 2011: 92, 119, 125, 132, 135, 139, 144). As these vessels were made of the same local clays (Groot 2011: 232) and do not occur outside this region, we may conclude that at least partly the same group resettled the tell several times.

The question of where these people went when they abandoned their villages remains debated. One possibility is that people abandoned their sedentary life in the Zerqa Triangle and migrated out of the valley, possibly towards the eastern plateau. The connection between both regions was well established and is visible in the high level of homogeneity between pottery assemblages (Groot 2011: 148). Furthermore, transhumance would have always been oriented towards this region. In this hypothesis, people shifted along the continuum between sedentary crop cultivation on the one hand and mobile animal husbandry on the other (Petit 2009: 229; Van der Kooij 2001: 299). In the alternative view, people never left the region, remained crop cultivators, and migrated between the different sites within the Zerqa Triangle (Groot 2011: 249). Unfortunately, synchronising the settlement histories of the different tells in the region is not possible to such a level of detail that would allow the identification of groups of people moving from one tell to the other.

From the point of view of the irrigation system it is unlikely that the region was completely abandoned for a long period of time. Not only do the canals need maintenance (restoration after a few decades of disuse is possible, but labour intensive), but a social organisation that regulates water distribution is also necessary. After a circa 50-year period of abandonment, the physical structure of the irrigation system would still have been discernible to some extent, but two full generations after irrigation was last practiced the social structure probably was not. The fact that such a quick oscillation between abandonment and resettlement was possible at all makes it likely that the irrigation system was rarely abandoned for a prolonged period of time. Use of the irrigation system does not necessarily imply a settled population. It may have been used by a largely mobile group during certain parts of the year or by a small portion of the group who remained in the valley year-round while the rest moved away during the summer (as was the case during the Early Modern Period, see below). Ethnographic parallels suggest that canal maintenance required most labour input during the period of winter rains when flashfloods regularly destroyed dams and parts of canals.[3] At that time everyone joined together to repair the damage as quickly as possible. This will have been the period when the pastoral segment of Iron Age society can be supposed to have been present in the Zerqa Triangle supplying much needed additional labour. The survey has identified low-density artifact scatters from the Iron Age that are similar to the remains left by Ottoman/early modern Bedouin (Kaptijn 2009: 196). Furthermore, the excavated tells contain phases of squatter habitation and phases that consisted only of numerous storage pits, evidence of human activity without permanent settlement (Petit 2009: 223, 224; Van der Kooij 2001: 297).

Irrespective of the precise nature of habitation, it is clear that residential mobility was high during the Iron Age. Furthermore, the faunal assemblage shows that the pastoral side of Iron Age subsistence was well developed. Iron Age communities seem to have shifted relatively easily along the continuum between sedentary crop cultivation and mobile animal husbandry, probably because both sides of the spectrum had always been incorporated in their society. Iron Age communities thus showed a high level of diversity in their subsistence. Movement up towards the eastern plateau, furthermore, allowed the exploitation of different environmental zones. The strong cultural ties with communities inhabiting the eastern plateau meant that the people of the Zerqa Triangle not only had intensive interregional contacts but also had contact with an environmentally distinct area. In all, the Iron Age communities in the Zerqa Triangle seem to have been resilient because of their diversity and flexibility.

Control from outside: the mamluk period

A very different socio-economic system prevailed in the Mamluk Period (AD 1250–1516) when the Jordan Valley was part of a much larger empire that was actively involved in the agro-economy of the region. Jordan was important to the Mamluk rulers, because it was one of the principal suppliers of wheat (Walker 2006: 80). While the organisation of cultivation, i.e., what to plant, when to plant, how to divide water, etc., was usually left to the judgment of the local farmers, the Jordan Valley formed an exception to this practice (Walker 2006: 80). Here, agriculture was dominated by the cultivation of sugar cane, a cash crop generating huge profits (Ashtor 1981: 95, 98).[4] The sugar cane was cultivated on plantations that were owned by wealthy entrepreneurs or the sultan (in later years the latter almost gained a monopoly). On these plantations the owner determined the crops, the irrigation arrangements, and rotation system, with all decisions being taken in the interest of maximising sugar cane profits (Walker 2006: 82). The cultivation of sugar cane is very demanding on the local environment. Being a tropical crop, it needs high temperatures and a lot of water as well as nutrients. Depletion of the soil, deforestation to procure fuel to process the sugar, and salinisation and pollution due to excessive irrigation are significant risks.

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[3] Based on interviews conducted in 2006 by the author (Kaptijn 2009: 310).

[4] Based on crop yields from late 19th-century Egypt (Rabino 1884: 429), the closest parallel in terms of environment and technology, an annual yield of circa 750 tons raw sugar could be realised from the Zerqa Triangle (Kaptijn 2009: 392). Using yields reported by writers from the period, i.e., Maqrizi and Nuwayri, each mill would have been able to produce between 4595/7983 and 9190/10625 moulds, a mould weighing between 10 and 16 kg (Kaptijn 2009: 393).

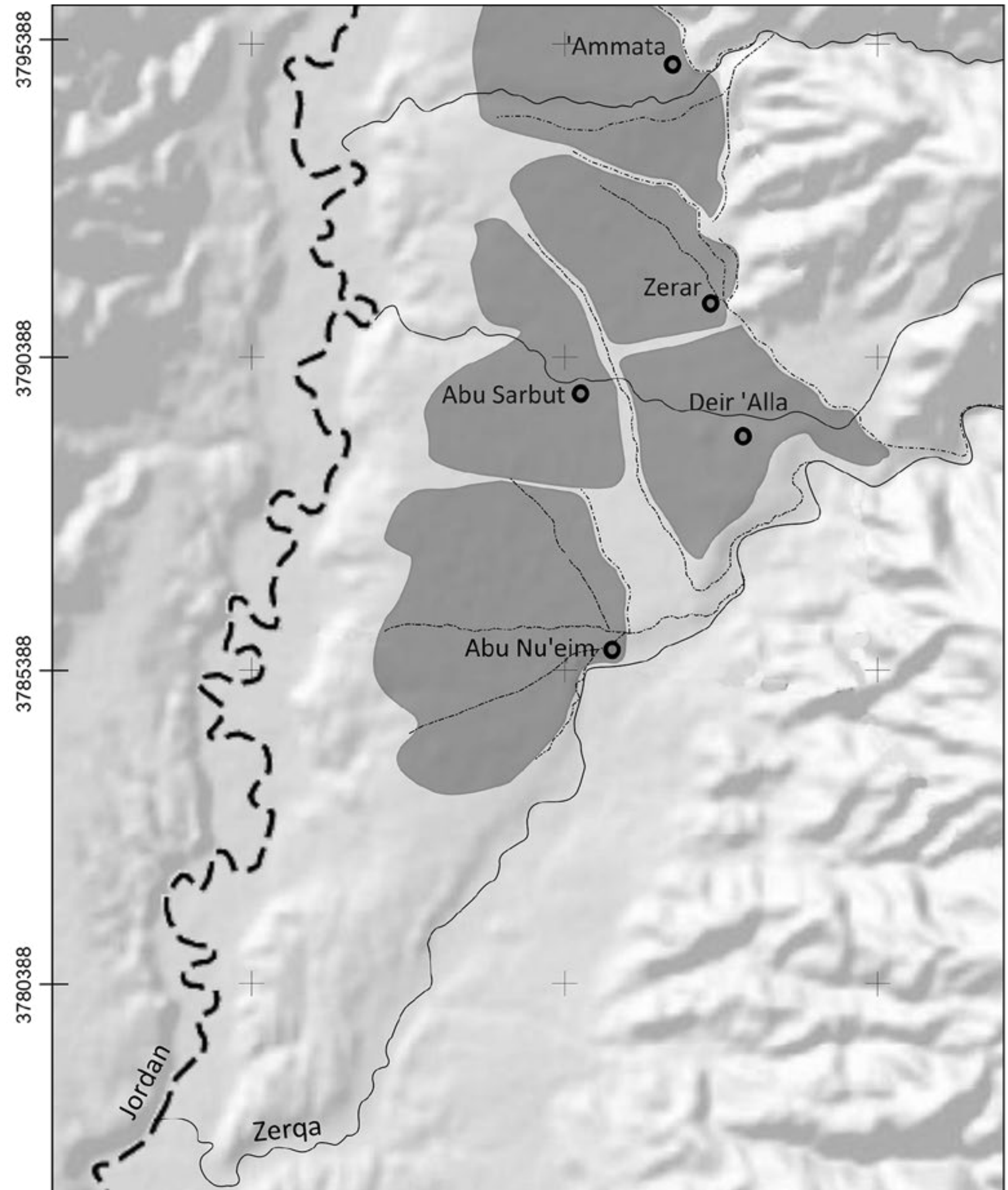

Figure 17.4. Mamluk watermills, irrigation canals, and hypothesised plantations.

In the Zerqa Triangle, sugar production is well documented. Sugar pottery sherds are very conspicuous byproducts of sugar production. To attain sugar, the cane is crushed to a pulp, then boiled, and the resulting syrup is left to crystallise in sugar bowls. Often the bowl broke when the sugar was extracted. Therefore, Mamluk sugar production sites are always littered with large quantities of sugar-pot sherds. In the Zerqa Triangle, four concentrations of sugar pottery were found (Figure 17.4) (Kaptijn 2009: 199, fig. 4). In three of the four cases, the remains of watermills, used to crush the cane, were found in close proximity (Kaptijn 2009: 320). In two instances, the watermills were connected to one of the main irrigation canals of the Early Modern Period, while the other mills are located along one of the other early modern primary irrigation canals (Kaptijn 2009: 283, 321). Given the rapid degradation of sucrose in harvested cane, the mills needed to be located on the plantations themselves (Galloway 1989: 16). The connection between primary irrigation canals and mills makes it likely that the territories of the plantations comprised the area irrigated by the main irrigation channel (see Figure 17.4). Being supplied by their own main irrigation canal, these plantations were largely independent of each other (a clear difference from the dependent Iron Age communities).

Mamluk subsistence in the Zerqa Triangle was, therefore, a very specialised one with a principal focus on cash crop production. There was little differentiation in local subsistence. Archaeobotanical analyses show that crops similar to the crops of the Iron Age were cultivated with the addition of a few newly introduced summer crops, i.e., wheat, barley, and smaller amounts of rye, millet, sorghum, beet, pea, lentil, bitter vetch, fruits like grape, fig, pomegranate, and the wild Christ's thorn (Grootveld 2000; 2008a: table 1). In contrast to the Iron Age, the pastoral segment of society was significantly smaller. Two analysed Mamluk assemblages from the region show that sheep and goats constituted only 36% and 40% of the assemblage in NISP and 13% and 23% in weight, while cattle comprised 50%/63% of the weight with pack animals like dromedary and *Equus* species forming another important group (Figure 17.3) (Van Es 1995; 2002). Although it is impossible to compare the numbers, the relative proportions show that sheep/goat herding assumed a less important role in Mamluk society. In an early Ottoman tax record, drawn up about a century after the decline of intensive sugar cultivation, none of the villages in the region is taxed for migrant herds, only a small amount is paid for 'goats and beehives' (these were taxed together as both denote animals at a fixed location) (Hütteroth and Abdulfattah 1977: 167–169).

Mamluk society was thus significantly more specialised and sedentary than Iron Age communities, making it potentially more difficult to face episodes of environmental stress. One aspect of Mamluk society, however, may have potentially relieved stress. This was the fact that the region in this period belonged to a large empire. The Mamluk government collected grain tax in kind and stored this in special central granaries to be used in times of need throughout the empire (Walker 2006: 82, 83). Although this practice was often exploited by rulers who forced purchases of wheat on the population at high prices, it might have alleviated stress in a specific region. Furthermore, this stored wheat was often used to provide rations to labourers on sugar estates (Satō 1997: 201). Harvesting and processing of the cane is very labour-intensive and often additional workers (sometimes slaves) were brought to sugar plantations to help during busy parts of the year or all villagers were forced to work on the plantations as a form of corvée labour (Galloway 1989: 41). The stored 'tax wheat' could have overcome the wheat shortage that might have arisen in dry years because most land, water, and fertiliser were directed towards sugar cane cultivation. This tax wheat could only be used by decree of the sultan or one of his deputies. However, during the 14th century, the sultan had almost gained a monopoly on sugar production in the Jordan Valley and historical records suggest that at least four of the five sugar plantations in the Zerqa Triangle were direct or indirect property of the sultan (Kaptijn 2009: 396). As such, a cropping system could have existed that could not have been successful in the long term in a small region.

However, in the long run, Mamluk society did not prove to be sufficiently resilient. During the late 14th/early 15th century, several cycles of drought and a general trend towards desertification occurred (Kaniewski *et al.* 2012: 3862; Van Zeist 1985: 199–204; Walker 2006: 94). Together with political turmoil, mismanagement, and abuse of power by (local) rulers, this resulted in the decline of Mamluk agriculture, sugar production, and in some regions the abandonment of villages (Walker 2006: 92, 94). The instability and unrest also affected the Zerqa Triangle. In AD 1396 the 'supervisor of the Jordan Valley,' Iyās al-Jarkashī, was imprisoned and executed by the sultan for mismanagement and abuse of his office for personal gain: he was accused of cutting off the hands of 70 men from the valley, of diverting communal irrigation water towards his personal plantations, of forcing inhabitants to buy his sugar at high prices, and in general of ruining the economy of the Jordan Valley (Ibn-Ṣaṣrā 1963: 254; Walker 2006: 92). Shortly after, in AD 1398, the governor of Syria visited the Jordan Valley and arrested emir Ǧulbān, who was at that time present on the plantations allotted to him by the sultan, being the lands of 'Ammata and al-'Adliyyeh in the Zerqa Triangle (LaGro 2002: 18). Both archaeological and historical data show that most settlements in the Zerqa Triangle continued into the early Ottoman Period, i.e., the 16th century, albeit without sugar production (Hütteroth and Abdulfattah 1977: 167–169). At some point in the 17th century, most if not all, permanent habitation ceased and the region became the winter campground of the Bedouin (Kaptijn 2009: 313–318).

The early modern period: clan-based society of settled bedouin

The Early Modern Period between the 1920s and the 1950s is an intermediate period between the era of Bedouin domination of the Jordan Valley from the 17th to the 19th century and the huge population growth and reorganisation of the irrigation system in the 1960s. In this period, the Zerqa Triangle was occupied by a clan-based society with clan territories organised on the basis of the irrigation system. On one side stood the so-called Hurr (free) or Asil (noble) tribe, who

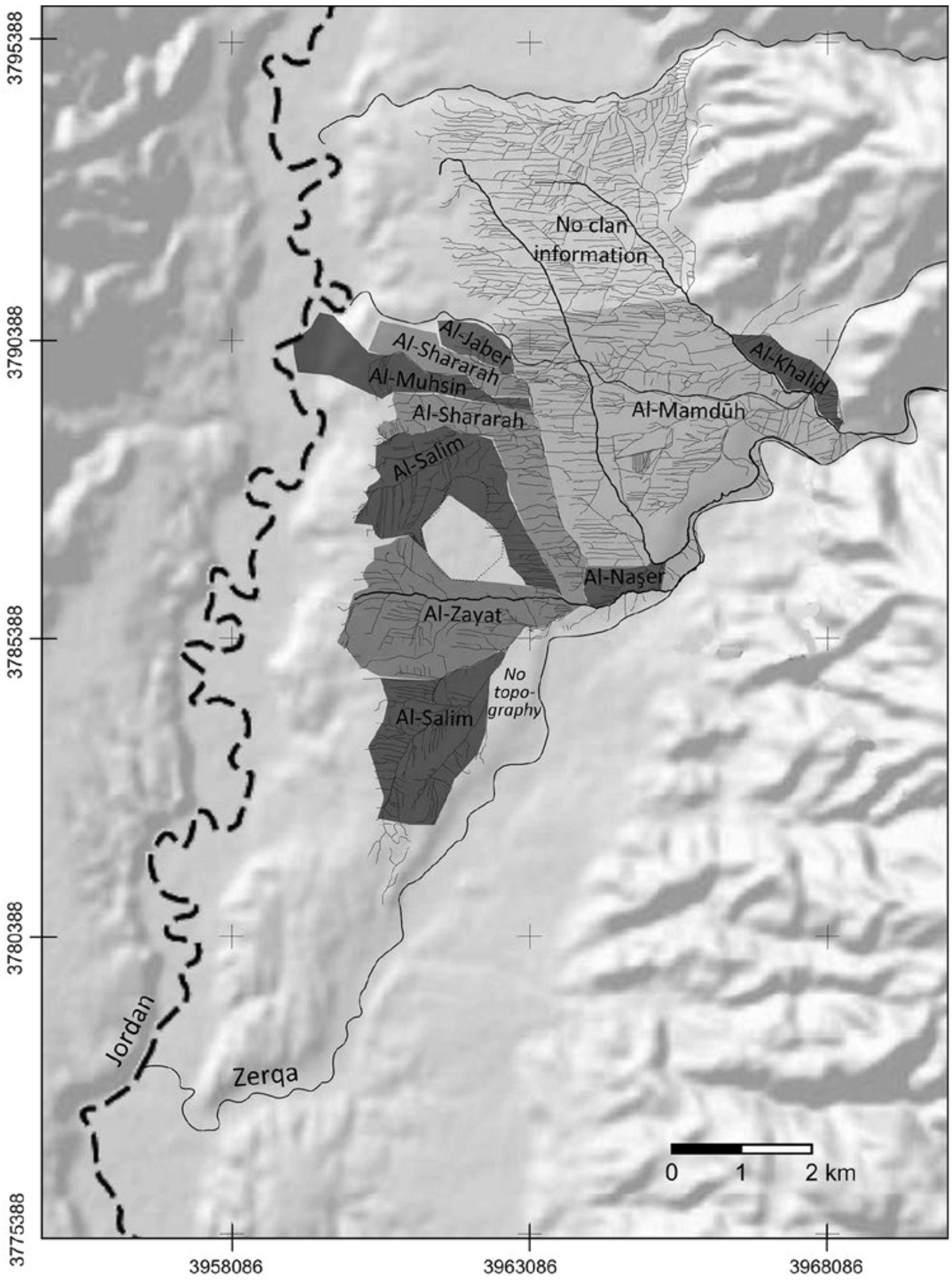

Figure 17.5. Early modern irrigation system and clan territories (adapted from Tarawneh 2014: fig. 2).

considered themselves the original inhabitants of the region, on the other side stood the Ghawarneh tribe, who were supposed to be more recent arrivals in the region (Tarawneh 2014: 41). There was a clear social hierarchy between the two tribes with members of the Ghawarneh tribe being looked down upon — a situation that persists to this day (Van Aken 2003: 36). This hierarchy is distinctly visible in the spatial organisation of the territories (see Figure 17.4). One of the two clans of the Hurr tribe, the Mamduh, occupies a territory that incorporates all the land irrigated by two of the three main irrigation canals. The land of the Shararah, the other Hurr clan, is fed by the same main irrigation canal as the four Ghawarneh tribes. Moreover, this territory is of the same size or even a bit smaller. The Shararah's higher position in the local hierarchy is clear, however, as its territory is located upstream from where the Ghawarneh clans tap their water (Kaptijn 2009: 382–383).

Internally the clans were homogeneously organised. All adult male clan members were allotted a plot of

Table 17.2. Reconstructed cropping systems.

Iron Age	**%**
fallow	40
wheat	32
barley	20
lentil	2
chick pea	0.5
broad bean	0.5
sesame	0.5
flax	1.5
vegetables	2
grape	0.8
date	0.2

Mamluk	**%**
Fallow	30
Wheat	20
Barley	12
Sorghum	3
Lentil	1
Pea	1
sugar cane	30
vegetables	2
Fruit	1

1953	**%**
Fallow	30.0
Wheat	30.0
Barley	16.8
Sorghum	9.3
Maize	1.2
Sesame	3.0
Tomatoes	1.4
Eggplant	1.2
cabbage/cauliflower	0.5
Onions	0.2
Potatoes	0.5
cucumber/squash	0.7
Beans	0.2
water melon	4.6
Citrus	0.5

land and every few years these plots rotated making sure that members who had cultivated a plot far away from an irrigation canal received a better plot near a canal in the new rotation (Tarawneh 2014: 28). The irrigation infrastructure remained the constant factor. The sheikhs of the different clans gathered daily to decide which canals would receive water and what amount (Tarawneh 2014: 38). All clans were communally engaged in the maintenance of the canals and in patrolling against water theft (Tarawneh 2014: 39). So while there was a clear social hierarchy between clans, which is reflected in the spatial organisation of the territories, internally the clans had a rather homogeneous social structure and similarly decisions on water division and maintenance of the irrigation system were communally arranged between the clans.

During the early 19th century, the Jordan valley was virtually devoid of sedentary population. In the Zerqa Triangle there was, by way of exception, one permanently occupied house, i.e., the house of the guard of the Abu Ubaydah mosque (Buckingham 1825: 12).

However, during the winter the valley was full of Bedouin tents. The Bedouin increasingly left people, often slaves, behind in the valley to cultivate some crops (Abujaber 1989: 69). By the late 19th/early 20th century, a few permanently occupied villages had appeared, consisting of settled Bedouin for whom this was their winter campground and migrants from elsewhere, but the Bedouin tribes continued to return to this area in winter. As late as 1953, aerial photographs show the presence of 393 black Bedouin tents versus 179 permanent structures, while a census recorded 119 dwellings in the same area (Kaptijn 2009: 295; Layne 1994: 44). Besides increasingly intensive crop cultivation, the region clearly incorporated a very significant pastoral component, probably with clear social links and/or kinship ties to the settled clans. Unfortunately, no data are available on the number and species of animals present at that time. However, Tarawneh states, based on interviews and historical research, that 1940s farmers in the Zerqa Triangle did not rely on crop cultivation alone, but also depended on animal husbandry of cattle, goats, and sheep (Tarawneh 2014: 45).

Early modern farmers were clearly using the irrigation system to intensively cultivate the region, including the growing of summer crops (for a list of crops cultivated in 1953, see Table 17.2). Recorded temperatures, rainfall, and river discharge (Jordan Meteorological Department) show that they were able to cope with yearly fluctuations in water availability. At the same time they had strong ties to pastoralists, either because part of their family herded the animals themselves or through kinship connections with still migrant Bedouin groups who came to the region in winter. This mobile component also brought the valley population in contact with other regions and environmental zones. Although surplus was traded at regional markets, this was only small-scale and there was only limited regional or national integration (Tarawneh 2014: 40).

In general, it can be stated that early modern subsistence comprised both animal husbandry and crop cultivation and included both sedentary habitation and mobile tent dwelling. On a general level this mode of subsistence is comparable to the Iron Age. However, developments like the rise of a central government, the incorporation into a global economy, and the influx of many new inhabitants, especially after 1948 and 1967, have resulted in increasingly intensive crop cultivation.

Comparing the different periods: an estimation

Under different cropping systems, the Zerqa Triangle has different carrying capacities as water is generally the restricting resource. To evaluate these differences a very tentative reconstruction of the cropping system has been made based on archaeological data, historical sources, and ethnography (Kaptijn 2009: 351, 363, 369).[5] This is by no means an attempt at an exact reconstruction, but a way to elucidate the difference between the cropping systems. In other words, the difference between cultivating only winter crops like people did during the Iron Age, an economy where sugar cane took precedence over everything else, and the cultivation of both summer and winter crops. Using data on the water demand of crops during their different growing stages, the total amount of water one crop or a combination of crops needs to mature successfully can be calculated (Allen *et al.* 1998). The irrigation system is taken as unchanging and a documented dry year (1960/1961) has been taken as an exemplary dry year. The amount of river flow and precipitation will undoubtedly have varied over the course of three millennia, but this specific dry year is taken as a representation of dry years that will always have occurred albeit with small differences in intensity and timing. Furthermore, ideal irrigation is assumed, meaning that plants are assumed to receive the full amount of water needed for a perfect harvest. However, a plant will survive on a lower amount although this is usually reflected in a reduced yield. Notwithstanding these drawbacks and assumptions, the difference between the cropping systems can be made apparent in this way and an understanding can be gained of the timing and relative extent of water shortages farmers might have experienced during dry years.

All three graphs show a peak in water demand during spring (March to May) (see Figure 17.6, lower graph). In this period most winter crops are in the process of grain filling which requires a lot of water, while rains have ceased and evapotranspiration is high. Under the Iron Age system, the irrigation requirement would have reduced quickly and would have been very limited during the summer months. The fact that sugarcane requires the entire summer to mature would have resulted in a continued high irrigation water requirement during the Mamluk Period. Only during the winter months, when temperatures are lower and precipitation occurs, would irrigation not have been needed. The situation during the Early Modern Period is similar to the Iron Age with the difference that irrigation would have been required for a longer period during the summer months and that the amount of irrigation needed during late spring would have been greater. This is due to the fact that both summer and winter crops were being cultivated and that these overlap during late spring.

When the irrigation requirement is compared to the available river flow, the actual area that could be irrigated in the Zerqa Triangle can be calculated (Figure 17.6, upper graph). Again, this is a fictitious scenario that assumes that the entire river was used for irrigation and that full irrigation took place. In reality, it will have been impossible to use a river in its entirety and choices will have been made to supply certain (drought resistant) crops with less water while crops vital for survival will have received sufficient water to produce an adequate harvest. The exercise shows that during the Iron Age there would have been only a short period when there was insufficient water to irrigate the entire valley plain, while this period of water stress would have been much longer during the early modern and especially during the Mamluk Period.

A further step can be taken. Drawing on data on the amount of land taken up by wheat in the different reconstructed cropping systems, local ethno-historical yields (Dalman 1933: 153,155; Ionides 1939: 23; Nedeco 1969b: 34–35), and historical and ethno-historical data on wheat consumption (Broshi 1993: 421; Dalman 1933: 158–159; Kramer 1982: table 2.3; Schwartz 1994: table 2; Wiggermann 2000: 186), an estimate can be made of the number of people that could have been sustained under the different cropping systems (see Table 17.3).[6] When these are compared to population estimates based on excavation and survey data (Kaptijn 2009: 354, 364, 370–373) an indication of the population pressure can be attained. While the individual numbers per period should not be relied upon too heavily because of the many uncertainties, the differences between the cropping systems are informative and show the different potential and possible stress during the three periods. From these tentative estimates it follows that it would have been the Iron Age population that was under most pressure during dry years albeit only for a short period. This relatively high level of stress during a ‘normal’ dry year (that would occur every few years) shows that Iron Age communities probably faced serious problems during severe dry years or longer dry periods, which probably happened every few decades. This would fit with the relative instability of permanent habitation

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[5] A more elaborate description of the method used and the decisions made can be found in Kaptijn 2009: 339–376.

[6] For a more elaborate description of this estimate see Kaptijn 2009: 352–254.

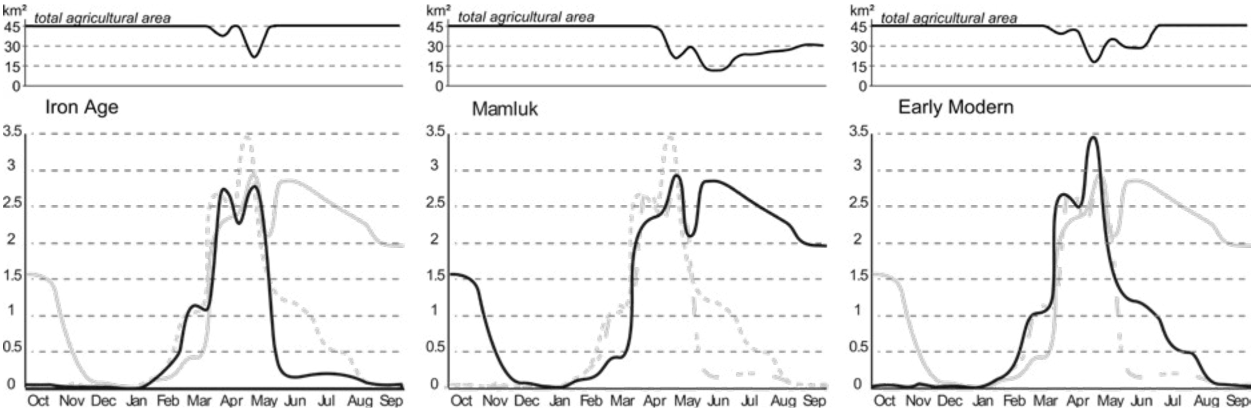

Figure 17.6. Total irrigation requirement of all cultivated crops (lower graph) and area that can be irrigated (when using total river flow) (upper graph).

Table 17.3. Estimated potential population and estimated actual population (* census data dwellings + counted Bedouin tents multiplied by (ethno-historical) nuclear family size (4–6 people)).

	Iron Age	Mamluk	Early Modern
Potential population normal year	4500	2500	5000
Potential population dry year	1750	1100	2300
Actual (estimated) population	3000	<1000	2000–3100*

during the Iron Age. While the population pressure in dry years would have been relatively limited during the Mamluk Period because of the relatively low number of permanent inhabitants, the period of stress lasted significantly longer. Furthermore, it is possible that during certain periods of the year seasonal plantation labourers were also present. In the Early Modern Period, stress existed for a considerable period during early summer. However, by that time most mobile pastoralists would already have left the area with their flocks, lowering the number of inhabitants drastically (although these people will also have needed stored supplies).

Conclusions

While raising the carrying capacity of a region significantly and making permanent habitation possible in regions that would otherwise be too arid, irrigation agriculture always remains vulnerable to periods of extreme aridity and social or physical disruptions of the system. There are different ways in which these vulnerabilities can be reduced or buffered, e.g., incorporating different modes of subsistence besides irrigated crop cultivation, incorporating different environmental zones in the activity area of a society, and regional integration via trade or membership to a larger cultural or political entity.

In the Zerqa Triangle, the three societies that practiced irrigated crop cultivation show different organisations of subsistence and associated levels of stability and vulnerabilities. The Iron Age is characterised by a fast oscillation between settlement and abandonment and hence by an instability in permanent occupation. However, at the same time this fast oscillation shows that there was no complete collapse of society, but a continuation in a way that is archaeologically poorly visible. The relatively rapid shift between irrigated crop cultivation and more mobile pastoralism was most likely possible because both modes of subsistence were always present in Iron Age society but varied in importance. It is because of this instability, or better yet flexibility, that Iron Age communities were able to endure in this region for such a long period of time.

Characteristic for Mamluk subsistence is the extreme focus on a tropical cash crop. This generated a very intensive form of irrigated agriculture, also because the processing also depended on the irrigation system (i.e., the crushing in watermills), dominated by an outside authority. This focus on cash crop production resulted in a limited diversity of subsistence as well as regionality. At the same time, the incorporation in the Mamluk Empire and the supply of wheat by the government to feed some of the plantation labourers will have reduced vulnerability. The independence of the plantations, because all relied on their own irrigation canal, undoubtedly reduced tensions between plantations and villages.

During the early 20th century, the Zerqa Triangle is a region in transition: from nomadic pastoralism to the extremely intensive irrigated crop cultivation of today. A relatively large portion of the population practiced nomadic pastoralism alongside permanently settled crop cultivators. This mode of subsistence has a high level of economic as well as regional diversity. While the clans were internally relatively homogeneously organised, hierarchical differences existed between the clans. This hierarchical division and the potential competition over water create sources of disruption of the system. However, no conflict has been recorded and regulations organising communal canal maintenance and water division seem to have functioned effectively.

In general, it can be stated that communities reliant on irrigation are vulnerable to disruptions in the water supply. This can be a disruption in the physical infrastructure, which is especially relevant in earthquake-prone regions such as the Jordan Valley, but also due to social or political factors. Diversity in mode of subsistence and environmental zones brings greater stability, while intensive irrigated crop cultivation brings greater agricultural potential and population capacity. Irrigation societies, therefore, always operate on a sliding scale with intensification of irrigated crop cultivation usually going hand-in-hand with increasing vulnerability.

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Recognition of Ancient Channels and Archaeological Sites in the Mesopotamian Floodplain Using Satellite Imagery and Digital Topography

Jaafar Jotheri and Mark B. Allen

Introduction

Examination of satellite imagery and digital topography has become an increasingly important tool for geologists, geomorphologists, and archaeologists, because this method integrates information drawn from multiple sources and provides accurately calibrated physical locations (Hritz 2010; Walstra *et al.* 2013). The use of such techniques to identify palaeochannels and ancient settlements has increased in recent times, particularly in the Middle East region (e.g., Hritz 2010; Pournelle 2003; Scardozzi 2011; Ur 2013; Walstra *et al.* 2011).

Methodology

The landscape of the Mesopotamian floodplain (Figure 18.1) is mainly structured by channel processes, including the formation of levees, meanders, scrollbars, oxbow lakes, crevasse splays, distributary channels, inter-distributary bays, and marshes. Moreover, several human-made features also organise and shape this landscape, such as canals and both modern and ancient settlements on scales from villages to cities (Verhoeven 1998; Wilkinson 2003; Yacoub 2011). For this study, a variety of imagery, including CORONA and QuickBird images, and SRTM (Shuttle Radar Topographic Mission) and ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) digital elevation data was investigated. We do not attempt to review all available topographic and satellite image platforms and datasets, but instead focus on some of the generic features of sites and landforms in the Mesopotamian plain and describe how they can be identified and interpreted using such imagery. We stress the physical appearance of features of interest rather than processing multispectral data for image enhancement. In part this is because such techniques are not applicable to the high-resolution panchromatic data we have used. Additionally, we find that such techniques are not always needed for the identification and interpretation of key features. The high spatial resolution of both panchromatic datasets and digital topography is the critical parameter.

Digital topography (srtm and aster)

SRTM data were acquired via a radar system on board the Space Shuttle *Endeavor* in 2000, with the objective of producing elevation data for most parts of the globe. Imagery is available for Iraq with the standard 90 m pixel size, and it can be freely downloaded online from the Consortium for Global Agricultural Research (CGIAR) website. The CGIAR website contains 5 x 5 degree tiles made from the original 1 x 1 degree data, which is available from the United States Geological Service (USGS).

ASTER data has a pixel size of 15 m, and include data in 14 spectral bands, from the visible to the thermal infrared wavelengths. A stereo viewing capability has made it possible to create digital elevation models, which are now also available (referred to as ASTER GDEM).

Most geomorphologic features of the palaeochannels and archaeological sites in the Mesopotamian floodplain have a relatively high topographic elevation with respect to the surrounding area; this phenomenon can make these features easy to identify in both SRTM and ASTER data (Altaweel 2005; Hritz and Wilkinson 2006). Digital elevation data may be more useful than either panchromatic or multispectral satellite imagery, even if the spatial resolution is lower, because the crucial element in identifying these features is the relative height. Conversely, some palaeochannels and archaeological mounds with low elevation and small dimensions cannot be identified by SRTM or ASTER because their resolution and accuracy are not sufficient to recognise certain features (Rexer and Hritz 2014). In this paper, we will therefore demonstrate how to use the visual expression of objects that are visible in QuickBird and CORONA satellite images to recognise palaeochannels and archaeological sites, as well as how to recognise these features by examining SRTM and ASTER topography.

SRTM and ASTER data can be used to examine and quantify topographic values of the surface features in several ways, such as by taking cross-profiles of river levees (Hritz and Wilkinson 2006). Simple topographic maps can be sufficient to show raised levee systems where such features are not clear on multispectral or panchromatic satellite imagery. In practice, not all ancient rivers are detectable in the topography data, for example, in the case of levees that have been destroyed by cultivation or quarrying, or where it has

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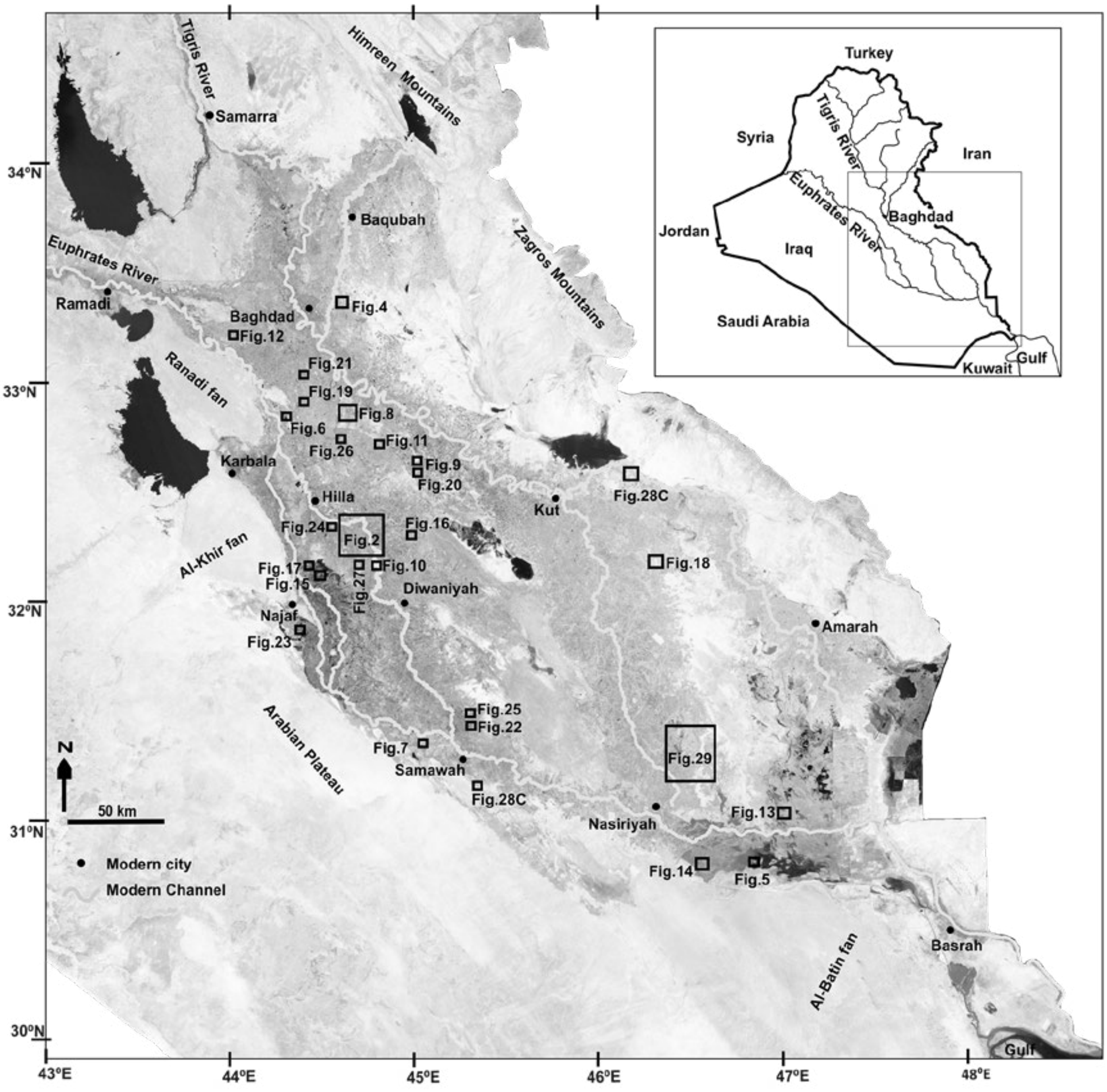

Figure 18.1. Location map of the study area, highlighting major modern river channels.

a relatively low relief with respect to the surrounding area. Standard GIS packages are able to present and process SRTM and ASTER data, with colour scale manipulation and artificial shading among the tools routinely employed to assist in the identification of levees and site features.

Corona imagery

CORONA images were derived from a United States intelligence programme. They were used from 1959 to 1972 and then declassified by the American Government in 1995. The data have been publicly available since 1998. These images can be searched and ordered via the Internet through the United States Geological Survey website or downloaded from the Arkansas University website. CORONA images are particularly useful for the reconstruction of ancient landscapes because they provide a valuable archival record of many surface features that have since been destroyed by urban development or large-scale agricultural development projects. As the original platform was high-resolution photography the images can be considered as panchromatic (greyscale) data.

Many natural surface features can be clearly identified in CORONA images because of the high spatial resolution of the imagery. The best ground resolution for the different CORONA missions is from 13 to 2 m (Ur 2013). Examples of these surface features include river scrolls and crevasse splays. Levees and archaeological sites can also be identified by the clear shadow they cast because of their relatively high elevation in relation to the surrounding area (Ur 2013). In fact, analysis of CORONA images has revealed several ancient river channels that were identified using other examined images.

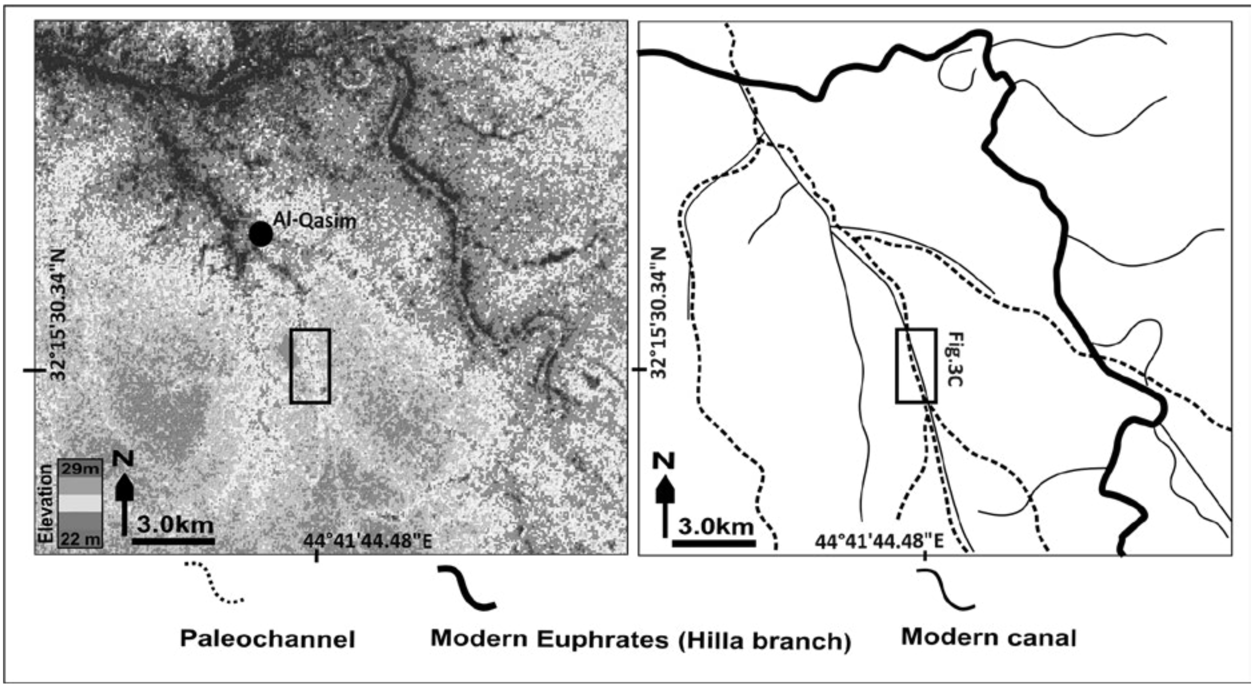

Figure 18.2. Example of elevated topography associated with a palaeochannel from an area to the south of Hilla, as it appears in SRTM data.

Quickbird imagery

DigitalGlobe is a commercial company founded in 1994 that provides high-resolution satellite images to governments and to companies such as Google. In 2009 it started to sell QuickBird satellite images to the public. Imagery is very high resolution: 61 cm for panchromatic data and 2.44–1.61 m for multispectral data. In 2007, the Iraqi Government purchased QuickBird images from 2006 for the whole of Iraq with resolutions of 0.6 m and with natural colour; these images were used in the present study. QuickBird imagery has proven to be useful in both verifying results and locating potential geomorphologic features that cannot be easily distinguished using other satellite data. Note that images derived from QuickBird (and other sources) and the GoogleEarth platform are subject to copyright arrangements.

Groundtruthing

Fieldwork for the specific study that is discussed in this paper was undertaken during February and March 2013. General observations were made at several locations, the main purpose of which was to ensure that there was agreement between what was identified in the remote-sensing work and what existed on the ground. We stress the importance of fieldwork, which should be used jointly with remote sensing studies. Fieldwork can permit 'groundtruthing' of observations made initially from satellite imagery and digital elevation models, and allows the collection of samples for dating and other analytical techniques. Alternatively, re-examination of imagery after fieldwork allows a regional-scale perspective on local features of interest identified in the field. However, in some cases, geomorphologic surface features such as ancient crevasse splays cannot be identified in the field although they are recognisable in imagery.

Useful characteristics

Recognising palaeochannels and archaeological site features and observing the differences between these features and their backgrounds involves a comparison of different features based on one or more of the visual elements of height, tone, texture, pattern, shape, shadow, size, and situation (Joseph 2005; Lillesand *et al.* 2008). Visual interpretation of QuickBird and CORONA images using these elements is the best way to identify these features, especially when SRTM and ASTER data analysis does not work, because of scale (resolution) issues.

Relative height

Relatively height refers to the difference amongst several features. As noted above, the tendency of both natural and human landforms to have relative height differences means that digital topography can be used for their identification and interpretation. SRTM (Figures 18.2 and 18.3) and ASTER (Figure 18.3) data

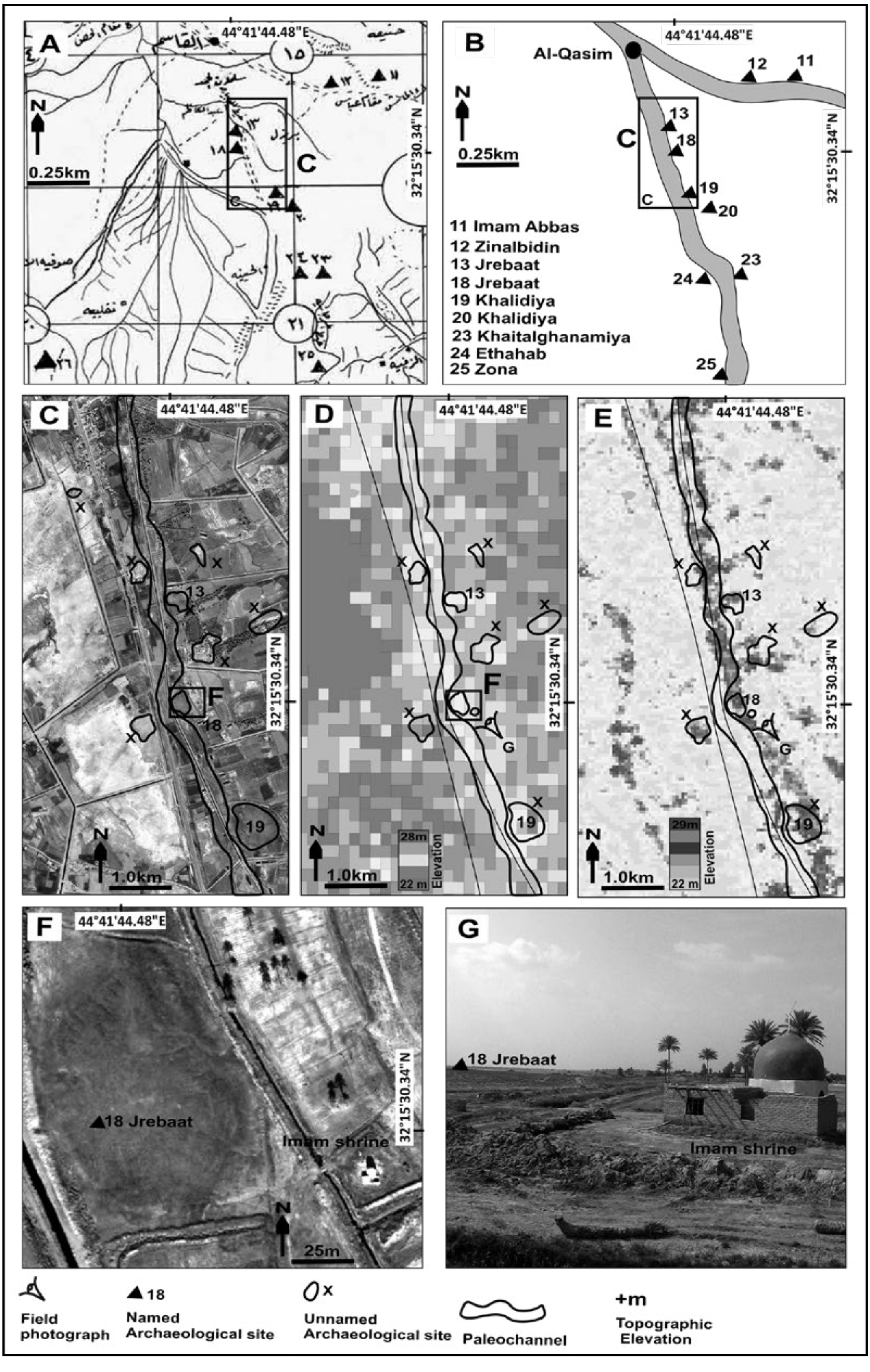

Figure 18.3. Tracing palaeochannels and archaeological sites using different datasets. (A) General Directorate of Antiquities (GDA 1970) map showing the location of archaeological sites and palaeochannels in Al-Qasim city in Babylon province. (B) Sketch showing palaeochannels and archaeological sites from Figure 18.3A. (C) QuickBird image covering part of Figure 18.3A. (D) SRTM data covering the same part of Figure 18.3A. (E) ASTER GDEM data covering the same part Figure 18.3A. (F) QuickBird image covering Jrebaat site (number 18). (G) Field photograph showing the Jrebaat site and Imam Shrine.

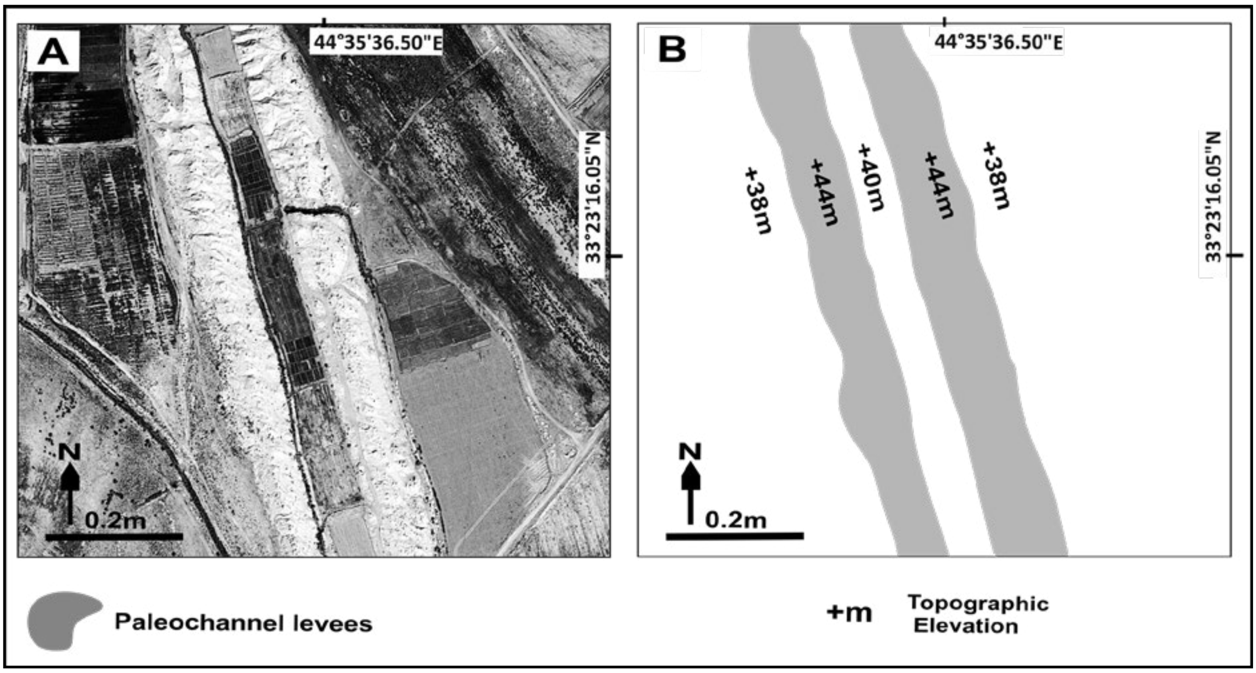

Figure 18.4. Example of a palaeochannel to the south of Baqubah City (Figure 18.1), highlighted by its tone in QuickBird imagery.

are used in the examples in conjunction with analysis of historical literature of the region and original fieldwork. The specific workflow involved initial location of palaeochannels and archaeological sites from the literature, followed by manipulation of the SRTM and ASTER data to produce maps with elevation scales that highlight the features of interest, followed by targeted fieldwork to sample material for radiocarbon dating. Note that the resolution of SRTM and ASTER data is sufficient in these examples to allow levees on distributary channels and canals to be mapped.

It is not easy to distinguish between palaeochannels and active or recently abandoned channels because both appear as ridges relatively higher than the surrounding area. However, in some cases, modern channels can be identified, because their two banks are high enough to be recognisable in relation to the channel itself. In contrast, palaeochannels appear as having one levee ('one ridge'), because the two levees have been eroded over time and the channel bottom has been filled, becoming one ridge (Figure 18.2). It has been noted in the present study that some of the Sasanian channels have a convex topographic profile i.e., two well identified levees with a channel between them. The topographic profiles of older channels (Babylonian or earlier), however, have a relatively smooth and concave profile.

Tone

Tone refers to the relative brightness and colour of objects in an image. Palaeochannel levees (Figure 18.4) and the isolated islands of archaeological mounds (Figures 18.5 and 18.6) can be recognised in QuickBird images because of differences in tone and colour compared to their surroundings. In QuickBird imagery, the essential element for distinguishing between different objects or features is the colour of the objects (Figure 18.7A), whereas in CORONA it is the brightness of the objects (Figure 18.7B). In some cases, it is difficult to recognise palaeochannels on QuickBird images (Figure 18.7A), because there is not enough relative brightness. Therefore, CORONA images (Figure 18.7B) proved better for tracing the features (Figures 18.7C and 18.7D). Additionally, in some places, the impact of modern cultivation is evident, seen in the changes of the tone of the irrigated land; archaeological mounds and levees become more recognisable as the farmer develops the area around the site.

Texture

Texture refers to the arrangement and frequency of tonal and colour variation in specific areas of an image. Palaeochannel scrollbar features (ridges and swales) are usually formed as a result of lateral migration of rivers, leading to the formation of parallel and systematic lines of ridges and swales. The present study revealed that this type of feature can occur as an associated feature of palaeochannels everywhere within the Mesopotamian floodplain. Therefore, this feature can be used as a characteristic in the identification of palaeochannels in high-resolution satellite images, such as QuickBird (Figures 18.8, 18.9, and 18.10) and CORONA (Figure 18.11A), because there is a relative

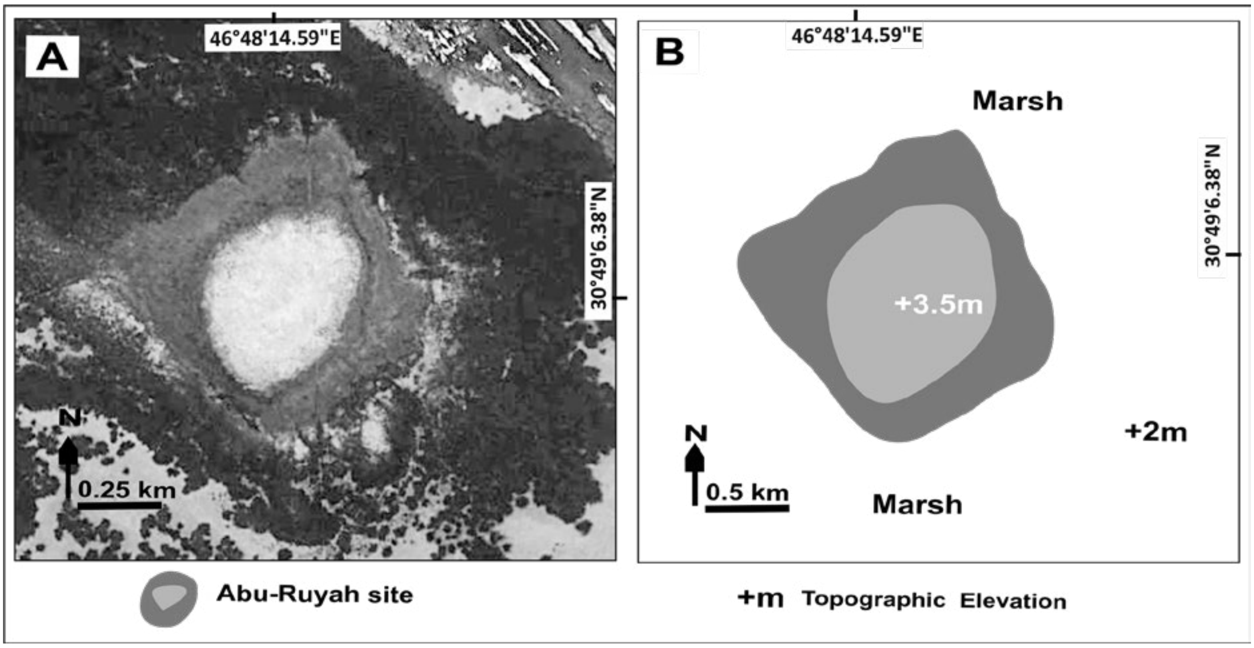

Figure 18.5. Example of an archaeological mound surrounded by marsh south of Iraq, utilising its tone in QuickBird imagery.

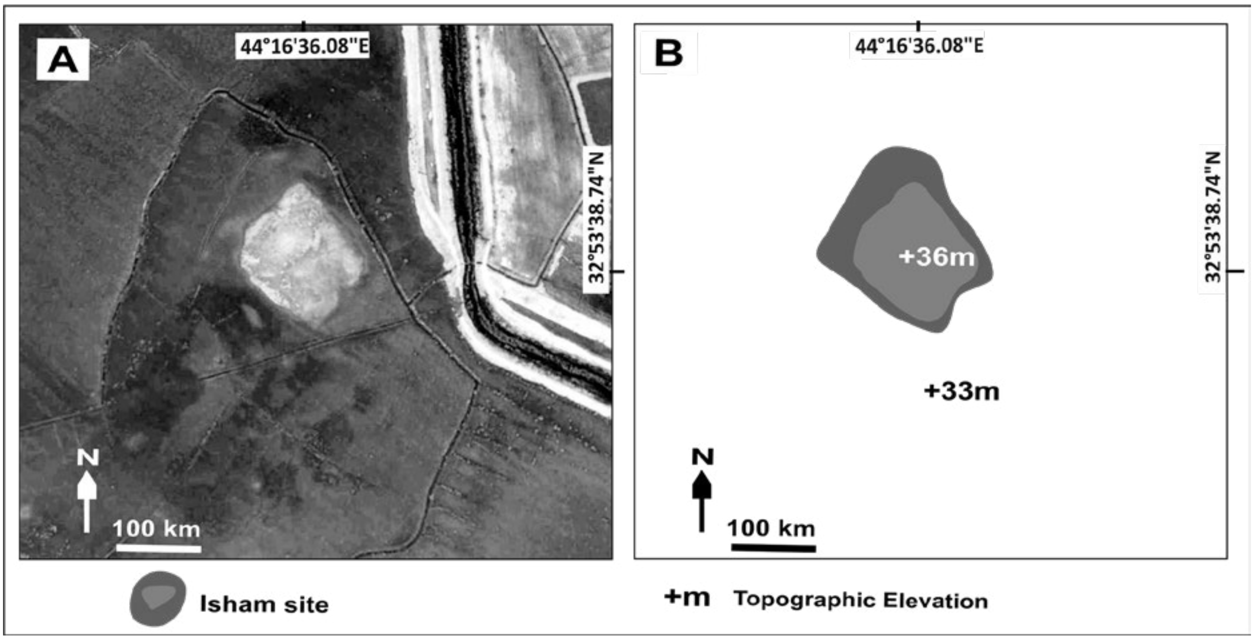

Figure 18.6. Example of an archaeological mound to the north of Hilla city, utilising its tone in QuickBird imagery.

difference in topographic elevation between ridges and swales. Furthermore, ridge sediments are coarser than swale sediments as a result of the natural sedimentation processes of meandering rivers, and therefore show up as a relative difference in tone and colour.

Such features are always associated with natural rivers (Figure 18.10), but are relatively rare in the case of human-made canals. However, sometimes such canals can meander over time so that scrollbars are formed, it will be across a smaller area in comparison with natural rivers. The scrollbars of natural channels can be difficult to detect because they were covered by more recent human-made canals, associated with natural river levees, or removed as a result of later cultivation projects. Most human settlements were built close to channel levees so, in the case of lateral river migration, new human settlements are built close

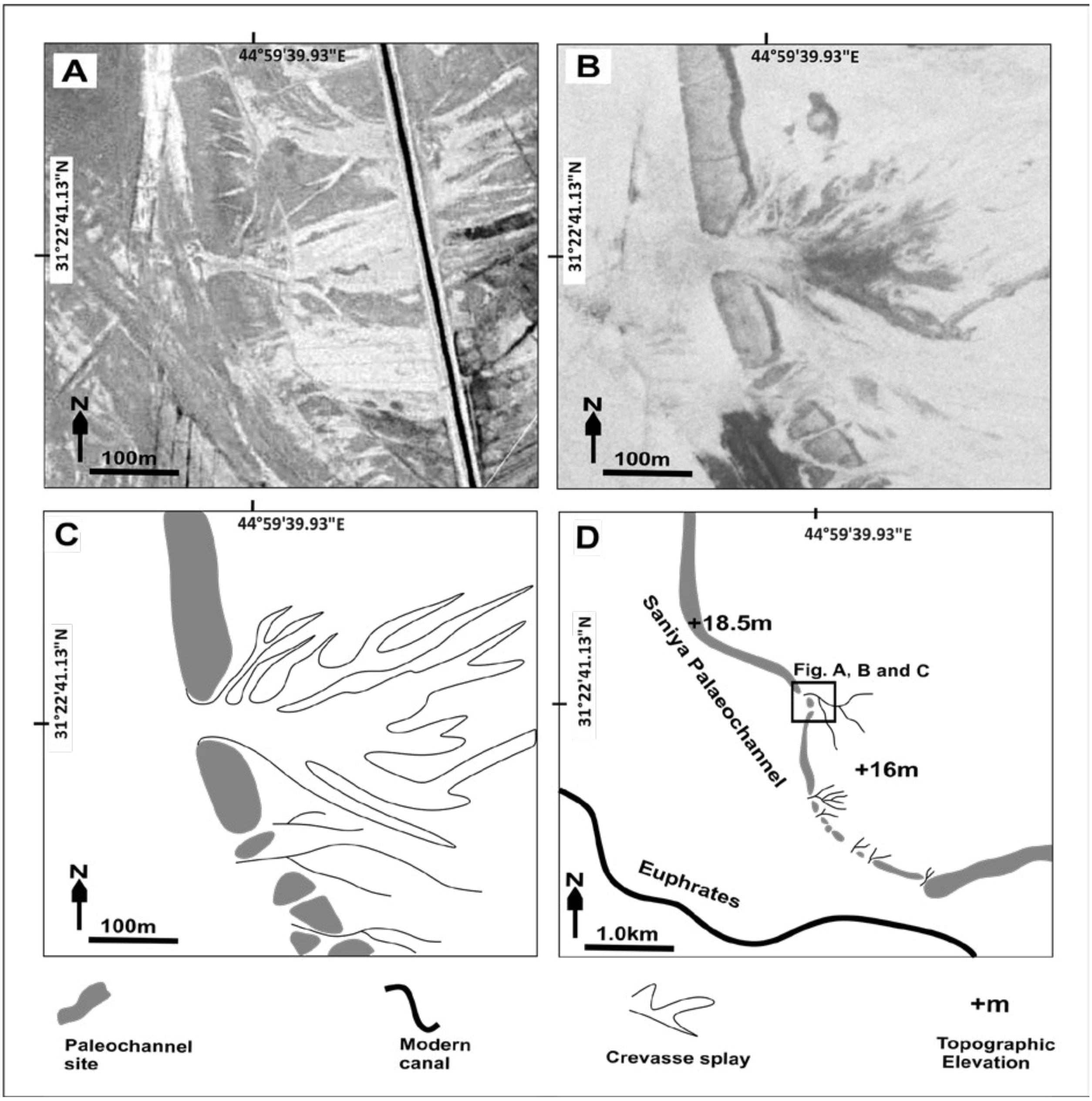

Figure 18.7. Example of a crevasse splay alongside a palaeochannel to the northeast of Samawah city, identified by the tone. (A) QuickBird image. (B) CORONA image. (C) and (D) Sketch showing tracing of the palaeochannel and crevasse splay.

to the new location of the channel. For this reason, human settlement patterns always follow the shape of these levees or scrollbars (Figure 18.10).

Pattern

Pattern refers to the spatial arrangement of features by repetition of similar tones, colours or textures. Many archaeological mounds have natural radial drainage (Figure 18.12) as a result of rain water running over the mound surface, which, over time, can become wider and longer and can easily be seen in QuickBird images, giving a good indication of the existence of archaeological mounds. However, the size of these drainages or grooves clearly reflects how the site has been affected by erosion. It can be seen that the site is wider and higher as the grooves become wider and deeper. Consequently, the size of these drainages may give an idea about the height of the site i.e., the greater the grooves, the higher the mound.

There are several mounds located in marshland areas, in the southern region of the Mesopotamian floodplain (Figures 18.13 and 18.14) that have been surrounded and partially covered by water. Most of these mounds are archaeological sites and were identified after

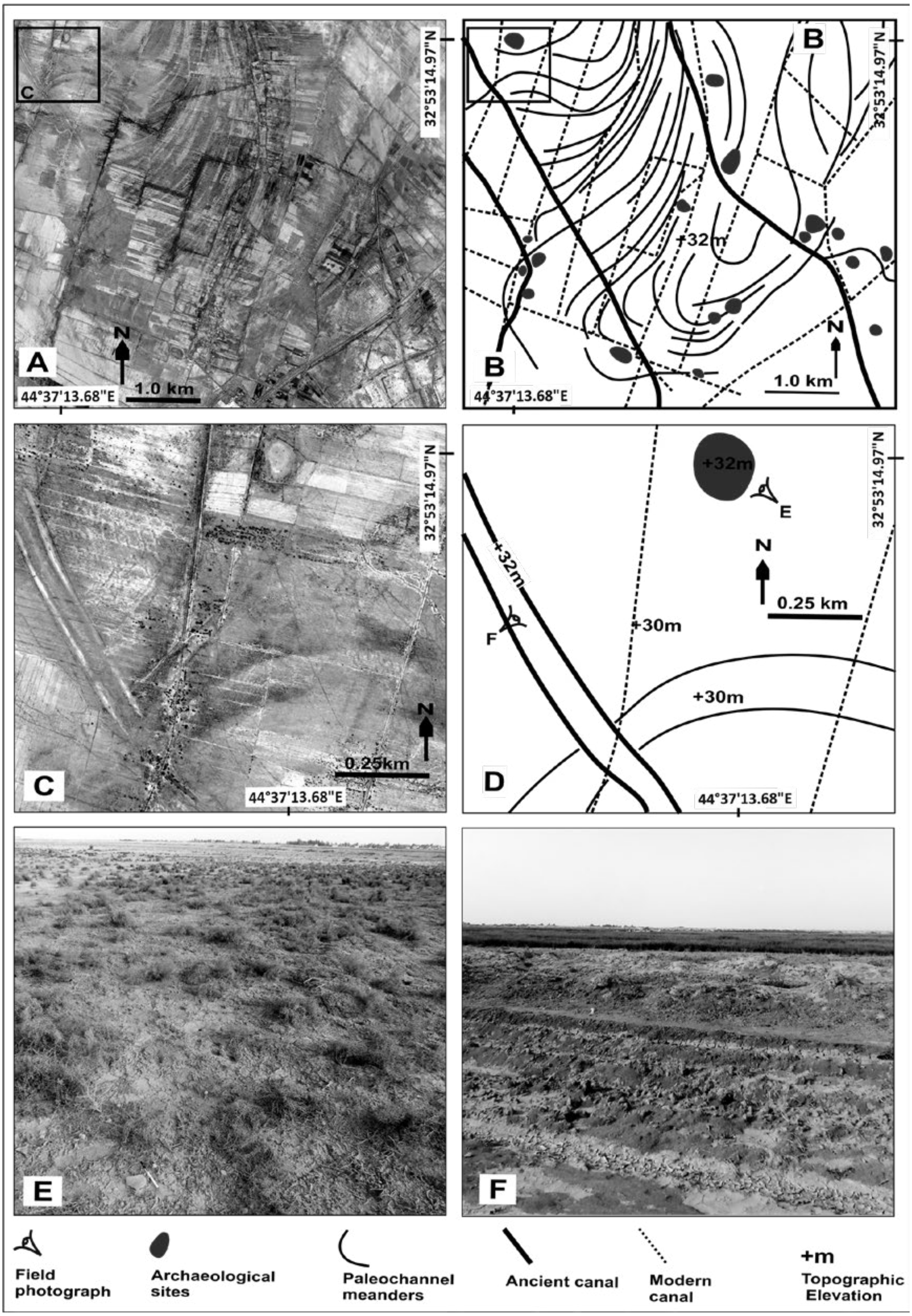

Figure 18.8. Recognition of palaeochannels and archaeological sites according to their texture in QuickBird images. (A) QuickBird image showing palaeochannel and archaeological sites located to the south of Baghdad. (B) Sketch showing the identified palaeochannel and archaeological sites of the image in (A). (C) QuickBird image showing the palaeochannel and an archaeological site in part of the image in (A). (D) Sketch showing the identified palaeochannel and archaeological sites of the image in (C). (E) Field photograph showing site of the image in (C). (F) Field photograph showing Sasanian canal visible in image (C).

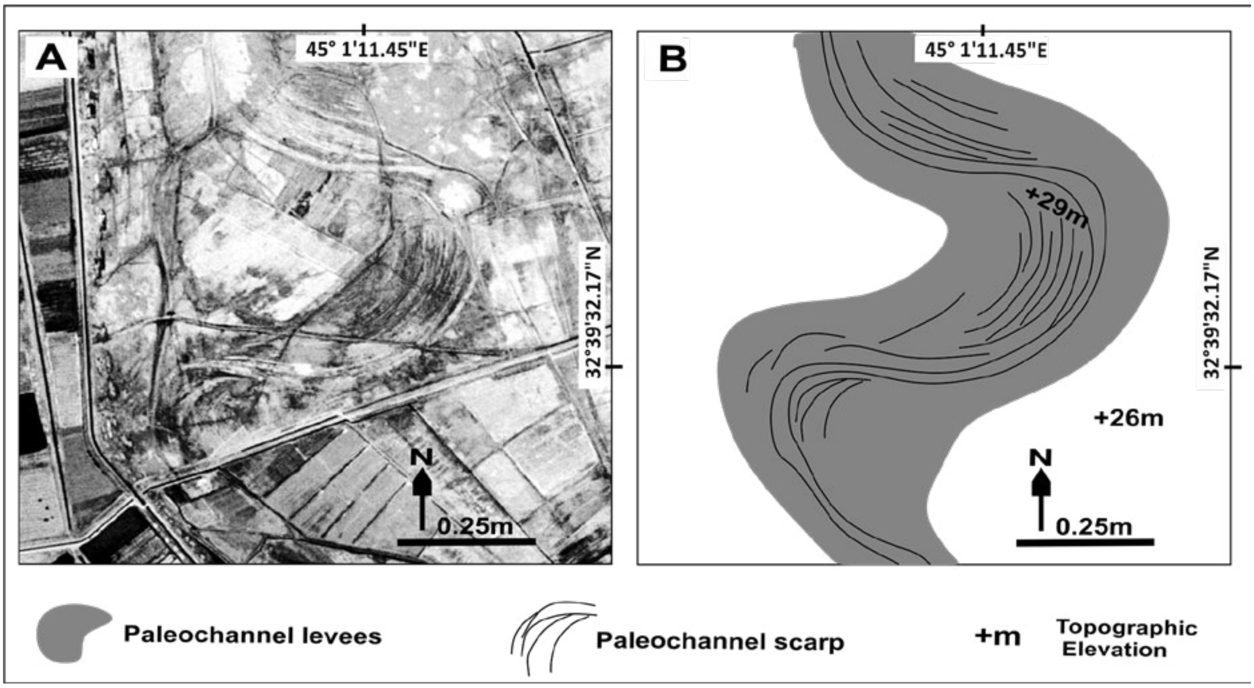

Figure 18.9. Recognition of palaeochannel and archaeological sites according to their texture. (A) QuickBird images showing palaeochannel meanders north of Kut City. (B) Sketch showing the identified palaeochannel meanders.

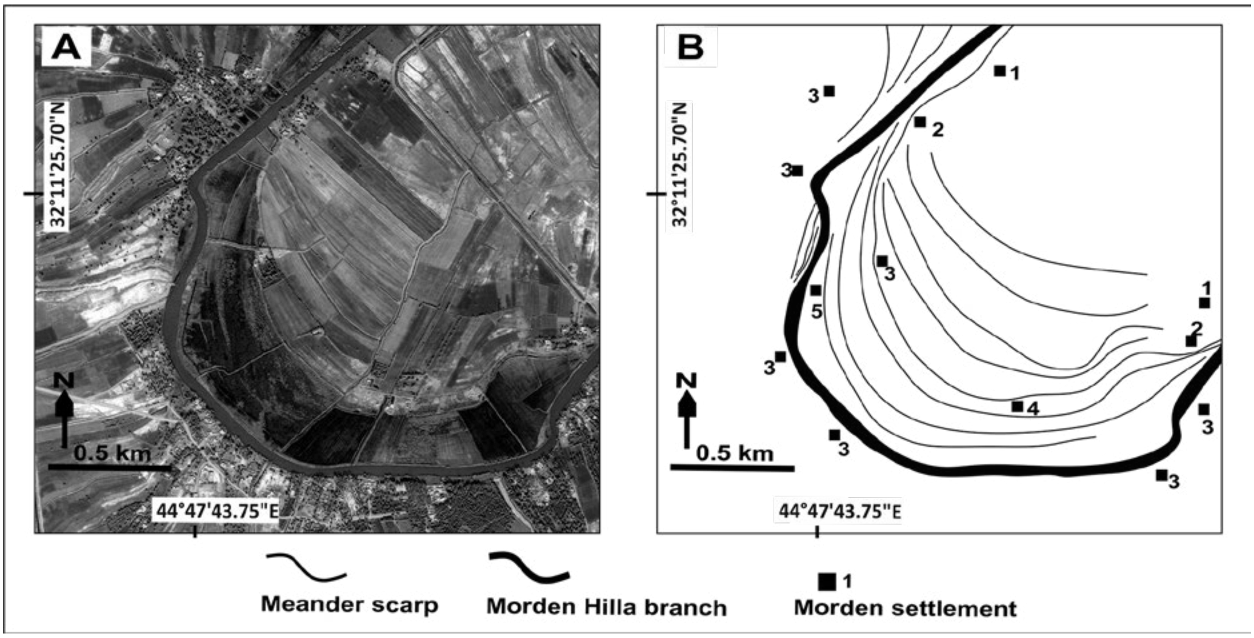

Figure 18.10. Recognition of palaeochannel meander scarps by their texture. (A) QuickBird images showing modern river meanders of the Hilla, north of Diwaniya city. (B) Sketch showing the identified meander lines and the relative ages of the houses (numbered); the oldest house was built close to the oldest meander line.

the southern marshes dried up in the 1990s (Ur and Hamdani 2014; see also chapters by Hritz, Darweesh and Pournelle; and Rey and LeCompte, this volume). Some of these mounds have recently been used as a base to build human settlements because of the lower risk of flooding or because it is the only dry land in the marsh area. These mounds can be seen clearly in QuickBird images but cannot be identified by SRTM and ASTER because of their low elevations (generally less than 2 m in relation to the surrounding marshes). It is

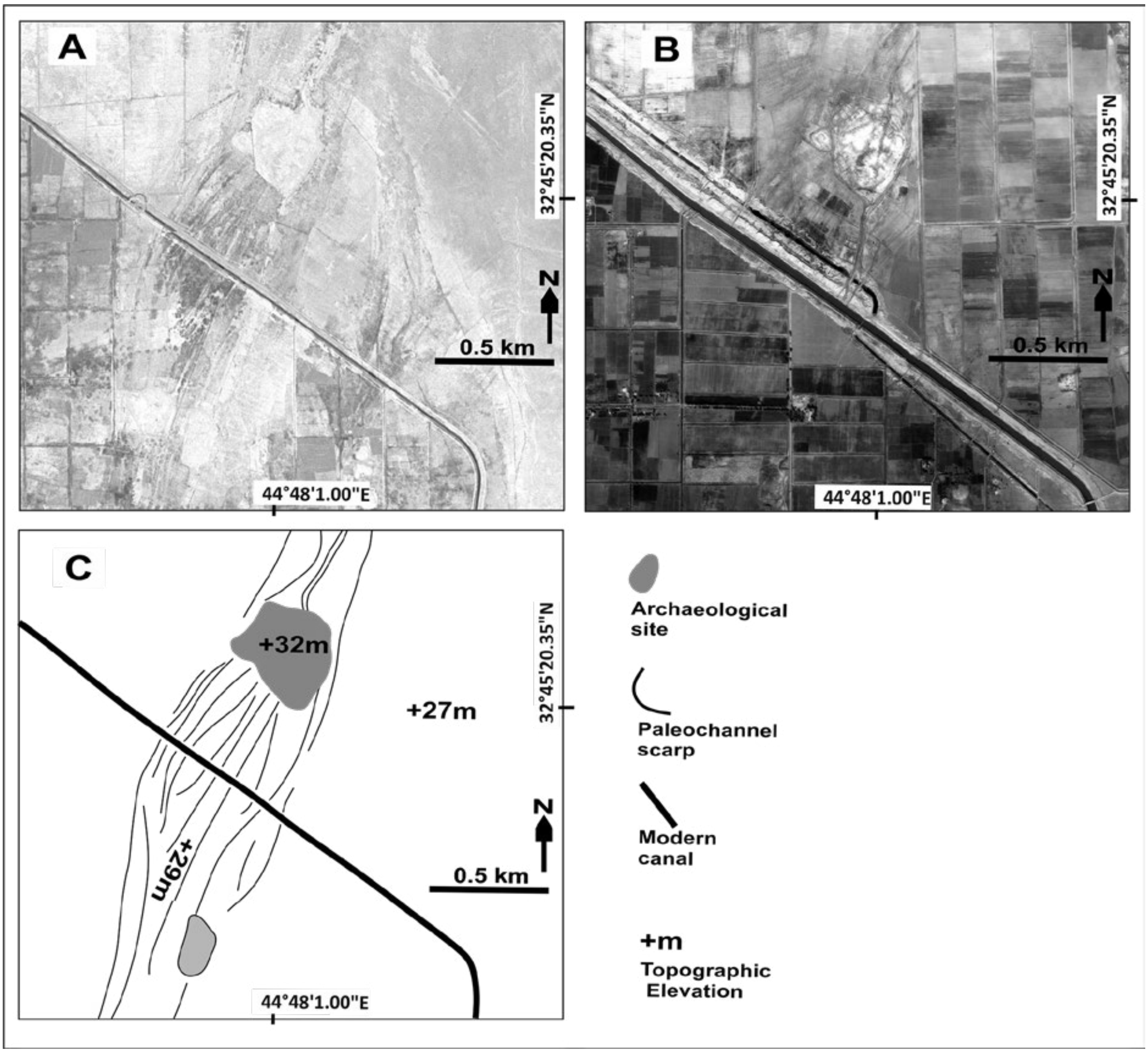

Figure 18.11. Recognition of palaeochannel meander scarps according to their texture. (A) CORONA images showing palaeochannels and archaeological sites, west of Hilla city (B) QuickBird image for the same area; note it is difficult to see the palaeochannel scarp. (C) Sketch showing the identified palaeochannel and archaeological site.

worth highlighting the fact that most of these mounds are characterised by radial features, 'linear hollows,' which are good indications of existing archaeological sites in the marsh (Figure 18.15; see Stone, this volume). According to Pournelle (2003) and Ur and Hamdani (2014), these features are the result of a combination of boat and buffalo traffic in and out of the marshes; they are preserved as soil and vegetation marks, which result from the micro-topography and variations in organic content and hydration levels compared with their surroundings. These features have also been recorded in Northern Mesopotamia and interpreted as the remains of tracks that were used to reach fields and outlying pastures (Wilkinson 1993). However, a limited number of cases have been observed in the present study where some of these features look like channels, i.e., there is water running between two banks and connected to a modern channel.

Shape

Shape refers to the general form, outline, or structure of individual objects. There are several common shapes for archaeological sites that can be used as key indicators, such as the geometrical shape of building foundations (Figures 18.16 and 18.17), the division of mounds into two parts by a palaeochannel (Figure 18.18), and the deviation of modern canals where they encounter a mound (Figure 18.19). Generally, the most common shapes of archaeological mounds visible in the imagery are elongated ellipsoid shapes, almost always arranged with the longer axis parallel to the associated

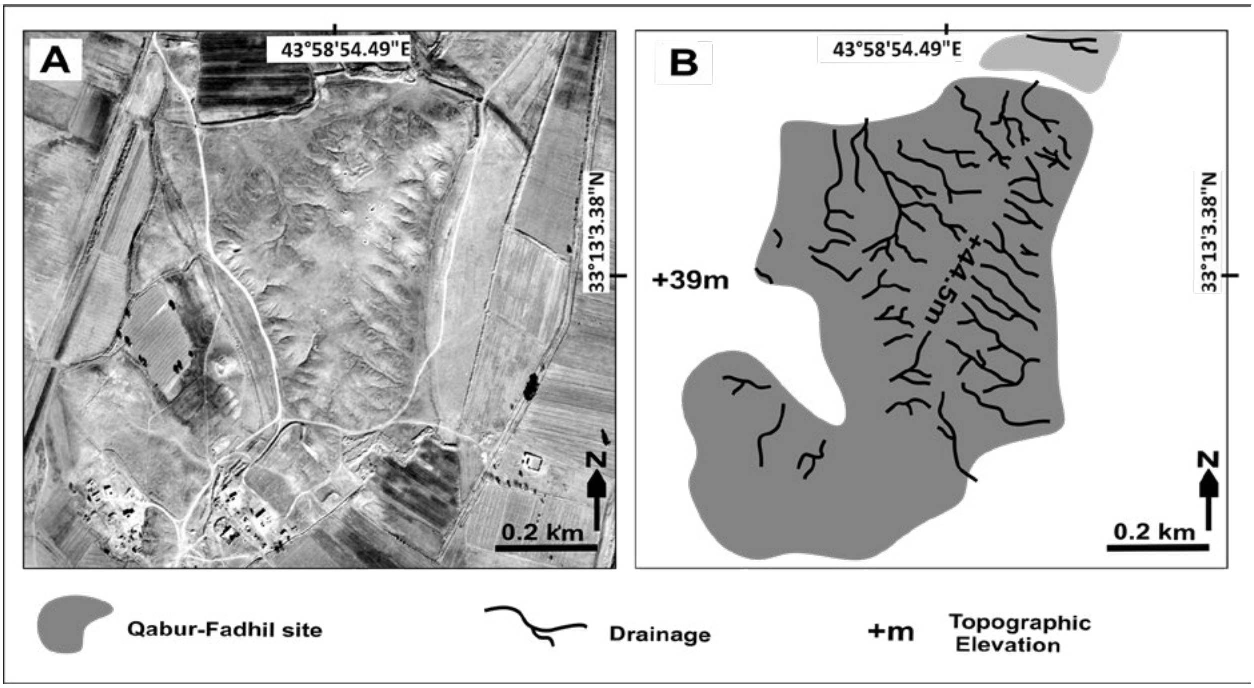

Figure 18.12. Recognition of an archaeological site according to its drainage pattern. (A) QuickBird image showing drainage pattern on a site mound, west of Baghdad (B) Sketch showing the identified drainage pattern on the archaeological site.

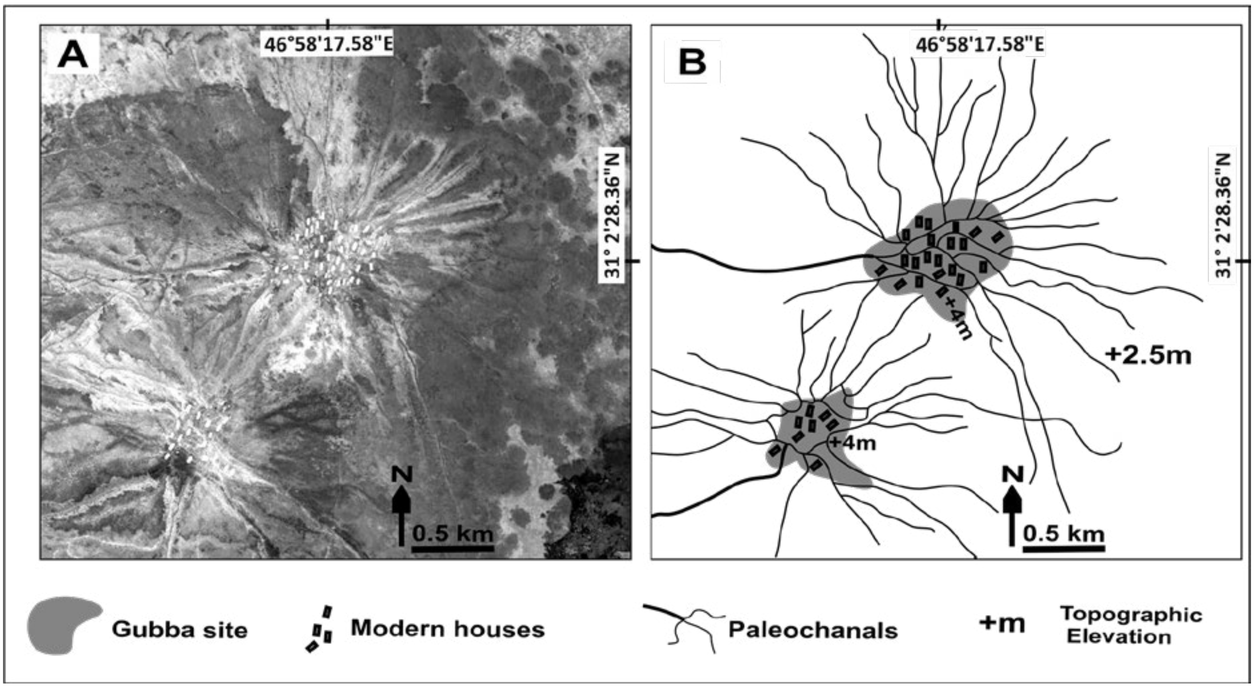

Figure 18.13. Recognition of an archaeological site according to drainage pattern around it. (A) QuickBird image showing drainage pattern around the site mounds, east of Nasiriya, formerly covered Chibayish marsh. (B) Sketch showing the identified palaeochannel and archaeological site.

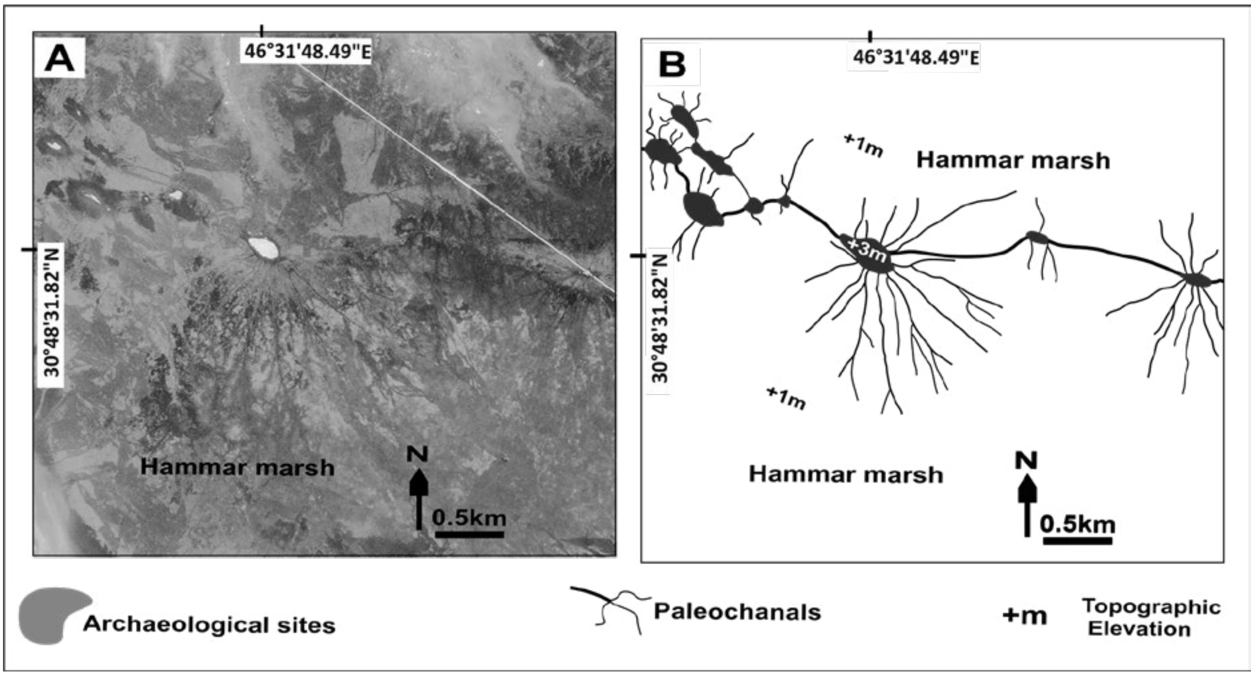

Figure 18.14. Recognition of an archaeological site according to drainage pattern around it. (A) CORONA image showing drainage pattern around the site mounds south of Nasiriya, covered by Hammar marsh. (B) Sketch showing the identified palaeochannel and archaeological sites.

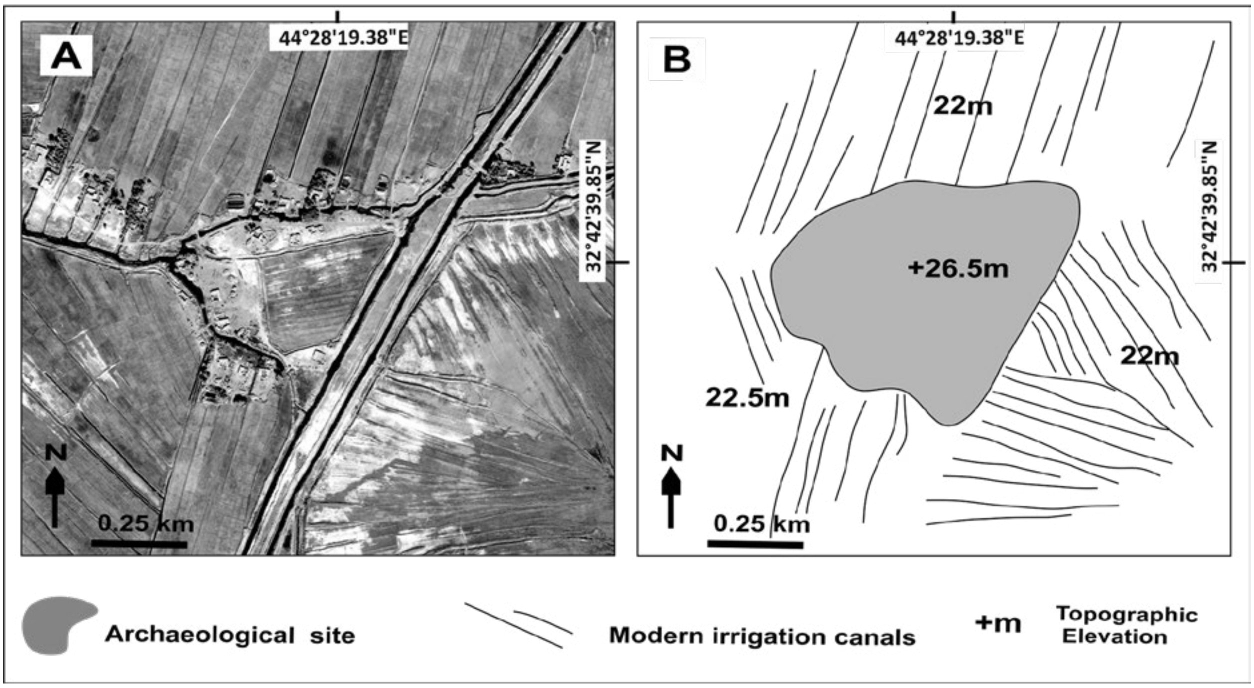

Figure 18.15. Recognition of an archaeological site according to drainage pattern around it. (A) QuickBird image showing drainage pattern around a site mound North of Najaf city. (B) Sketch showing the identified archaeological sites.

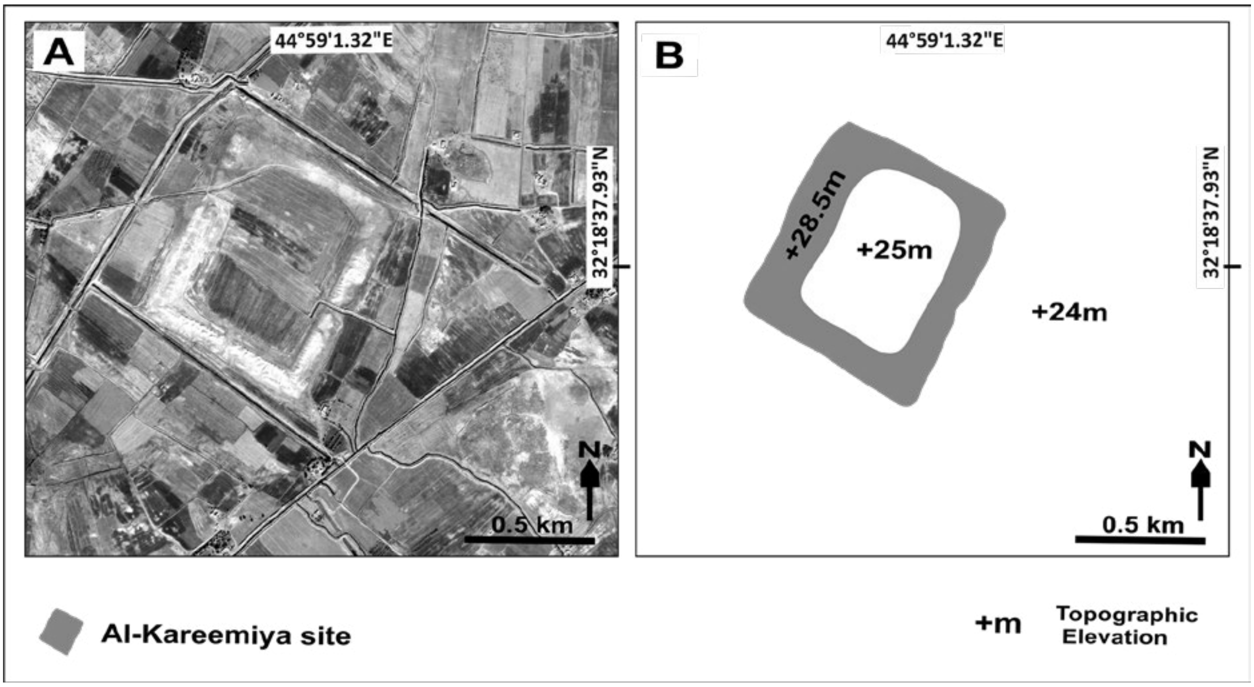

Figure 18.16. Recognition of an archaeological site according to its shape. (A) QuickBird image showing the rectangular foundation of an archaeological site southeast of Hilla city. (B) Sketch showing the identified archaeological sites.

channel (Figure 18.20). This principle might be used to predict the location of unrecognised palaeochannels. Remarkably, the shape of mounds occasionally reflects shapes of covered buildings (Figure 18.20), as the wall that surrounds a group of detached houses or large public building is also always built parallel to the associated channel (Figure 18.20).

Shadow

Shadow refers to a dark area shaped by relatively high features that block light. In fact, there are several sites that can typically be marked by shadow, particularly those sites where the remains are distinctly above the ground surface such as ziggurats, castles, and shrines. Most palaeochannels and buried archaeological sites are not sufficiently tall or appropriately shaped to create shadows, but in some cases shadows can give an indication of the height of the objects associated with the archaeological site, such as trees (Figure 18.21) and shrines or mosques (Figure 18.22).

Size

The size of features is a function of scale in an image. There are several objects that look like palaeochannels and archaeological sites; for example, unpaved roads look like palaeochannels but have a smaller size. There are two features that look like archaeological sites: seed winnowing (Figure 18.23) and modern human-made mounds (Figure 18.24). They have the same shape, colour, and elevation as an archaeological site, but not the same size.

Situation

Situation considers the relationship between other recognisable objects or features near to the target of interest. There are several objects or features that are normally associated with palaeochannels and/or archaeological sites, for example, the location of holy shrines (Figure 18.22), because the building of shrines as graves for sacred deceased people is a common Islamic custom in the Mesopotamian floodplain. Most of these shrines were built on relatively elevated areas in order to avoid flooding and groundwater. Therefore, they were built on channel levees or archaeological mounds. Most of these shrines can be recognised in QuickBird images and they can give a good indication for the identification of palaeochannels and archaeological sites. Distinct signals exist for looting; as the scatter of pits usually associated appear as pockmarks on the site (Figure 18.25). Some sites are surrounded or part-surrounded by modern urban areas (Figure 18.26), and, there are instances of small, isolated modern sites on larger ancient sites (Figure 18.27).

A natural example of situation being an important parameter is the occurrence of crevasse splays (Figure 18.28) adjacent to the main channel (Wilkinson *et al.*

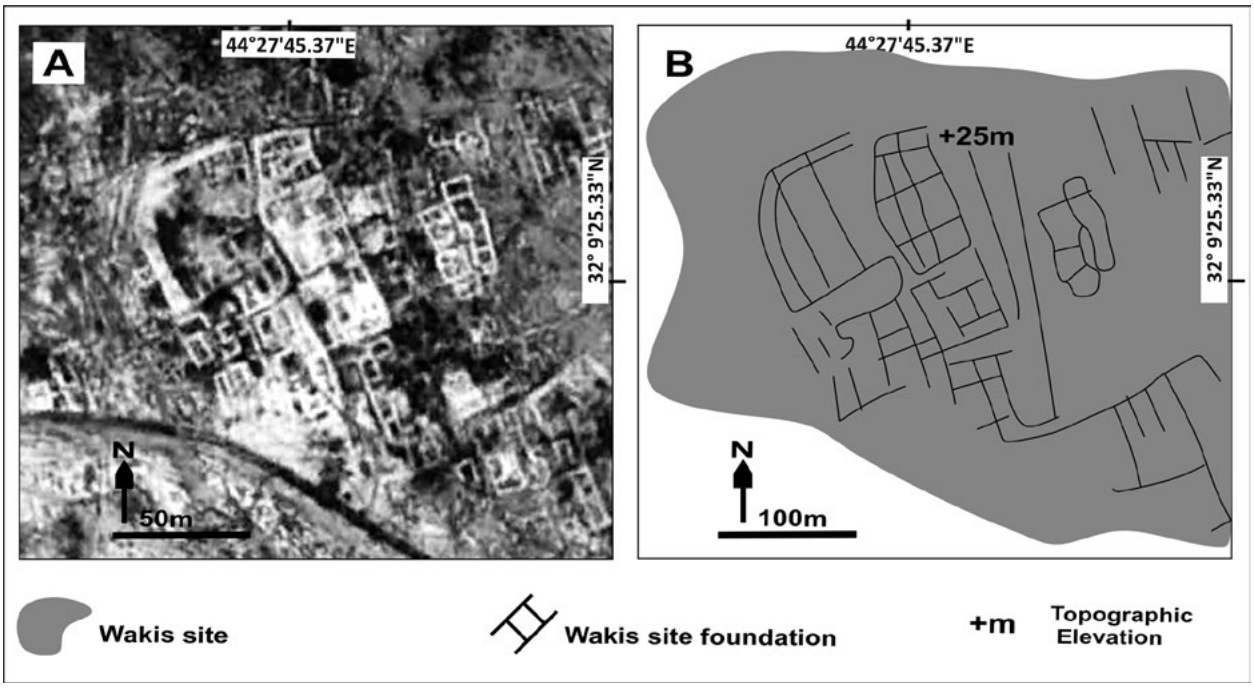

Figure 18.17. Recognition of an archaeological site according to its shape. (A) QuickBird image showing foundations of archaeological site northeast of Najaf city. (B) Sketch showing the identified archaeological site.

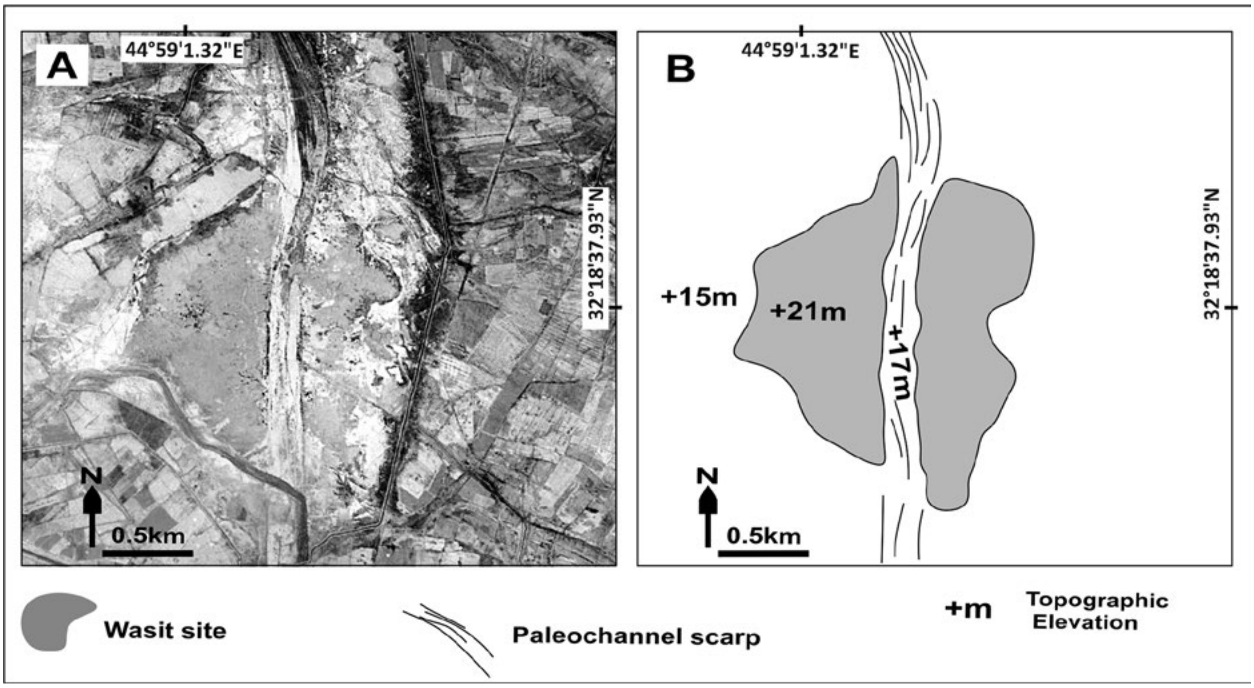

Figure 18.18. Recognition of an archaeological site according to its shape. (A) QuickBird image showing two loops of archaeological mound divided by palaeochannel southeast of Kut city. (B) Sketch showing the identified archaeological site.

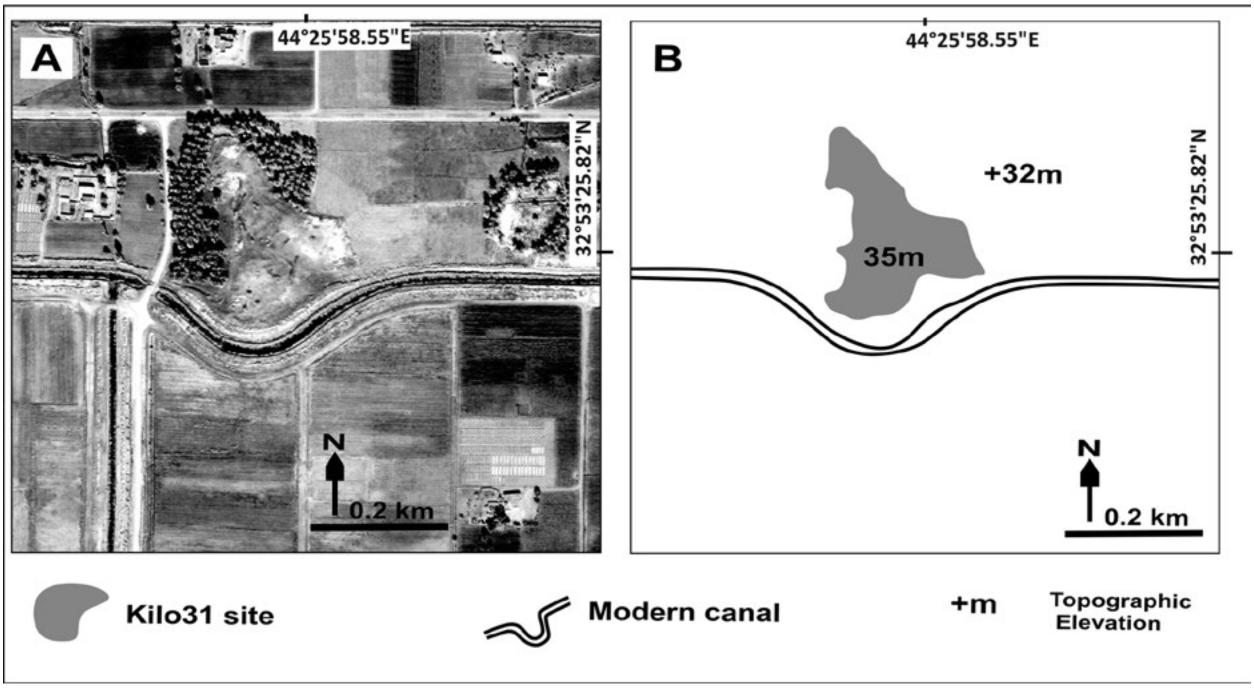

Figure 18.19. Recognition of an archaeological site according to its shape. (A) QuickBird image showing deviation of modern canal close to the archaeological mound south of Baghdad. (B) Sketch showing the identified archaeological site.

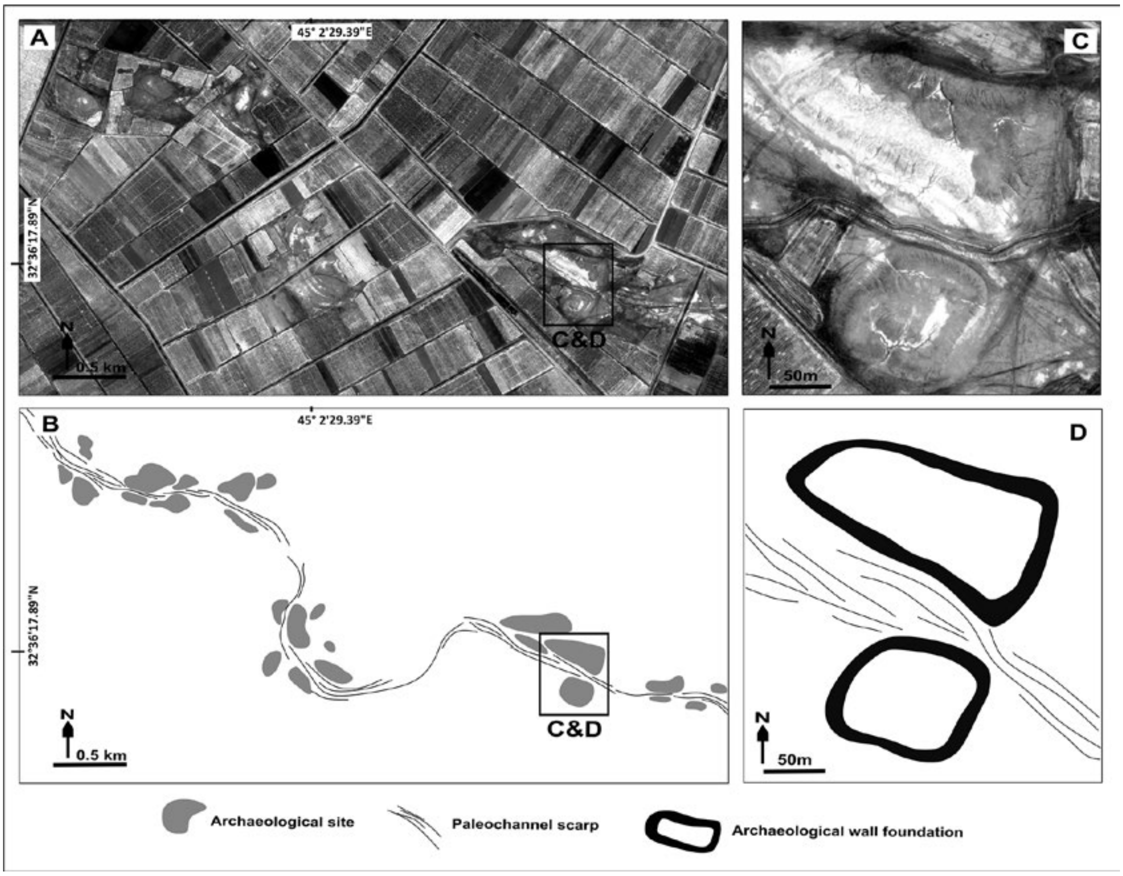

Figure 18.20. Recognising palaeochannel when the shapes of the associated sites are elongated ellipsoid shapes and arranged parallel to the channel. (A) QuickBird image showing archaeological sites associated with palaeochannel (B) Sketch showing the identified archaeological sites. (C and D) Two elongated sites reflect shape of covered building and parallel to the channel.

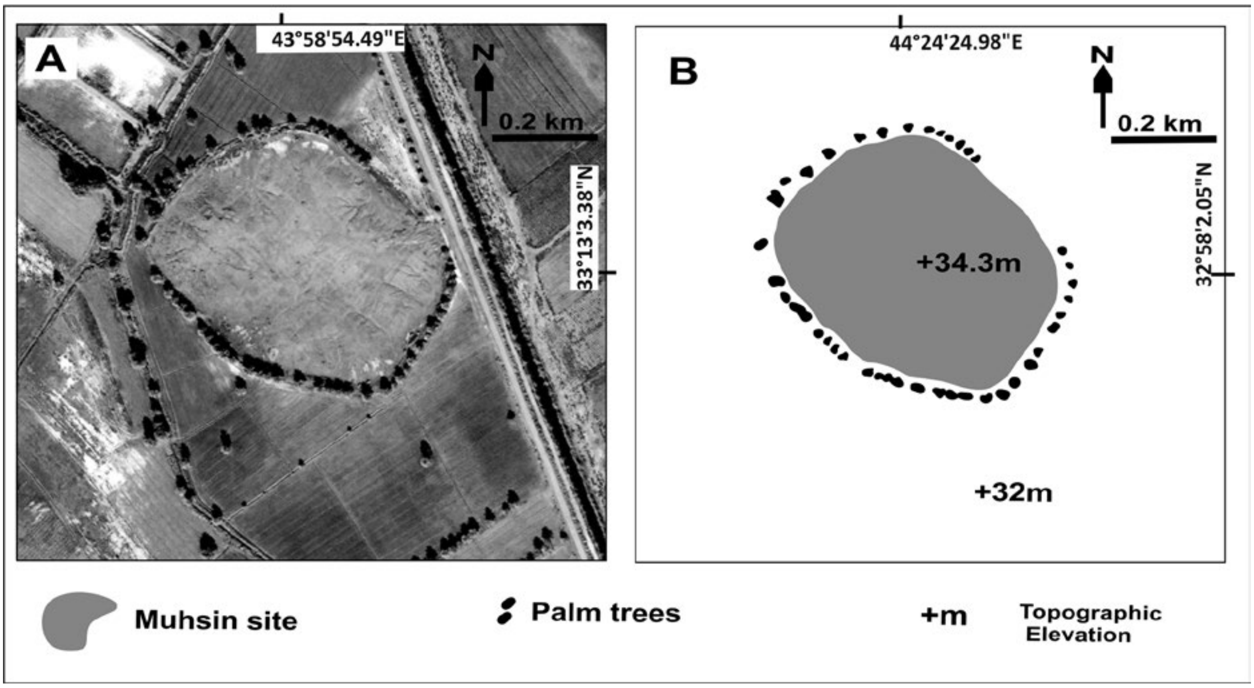

Figure 18.21. Recognition of an archaeological site according to shadow. (A) QuickBird image showing high trees around an archaeological site south of Baghdad. (B) Sketch showing the identified archaeological site.

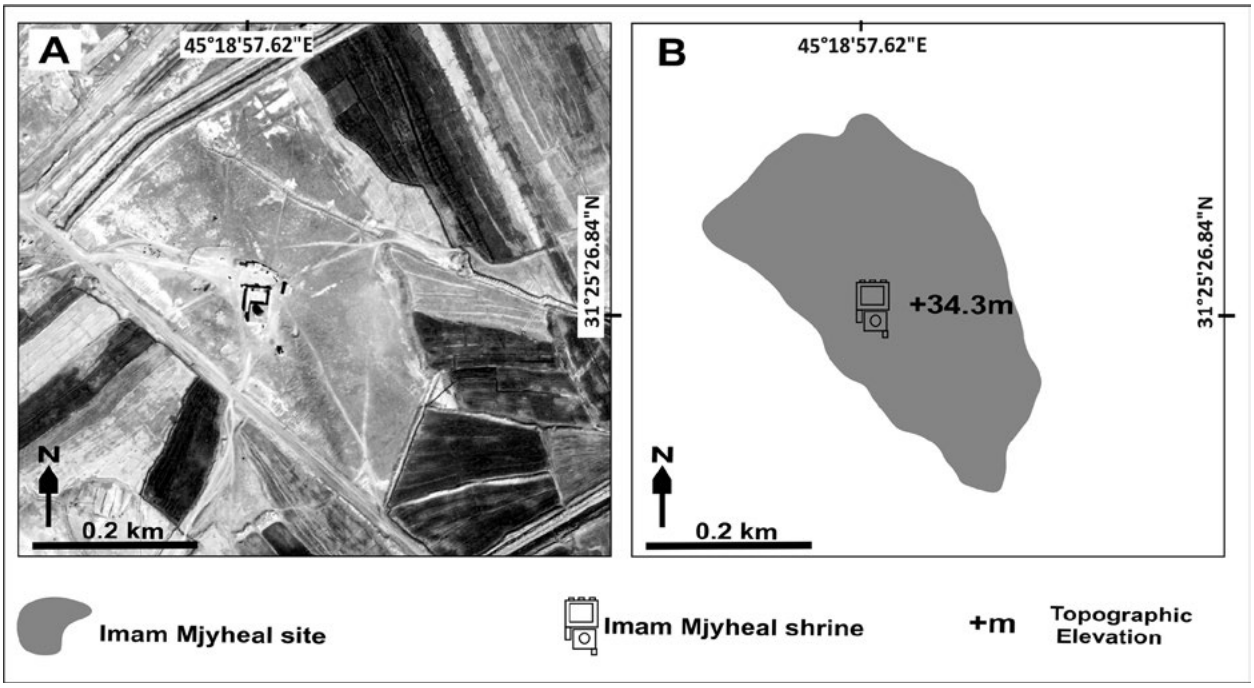

Figure 18.22. Recognition of an archaeological site according to shadow. (A) QuickBird image showing a shrine over an archaeological site south of Diwaniya city. (B) Sketch showing the identified archaeological site.

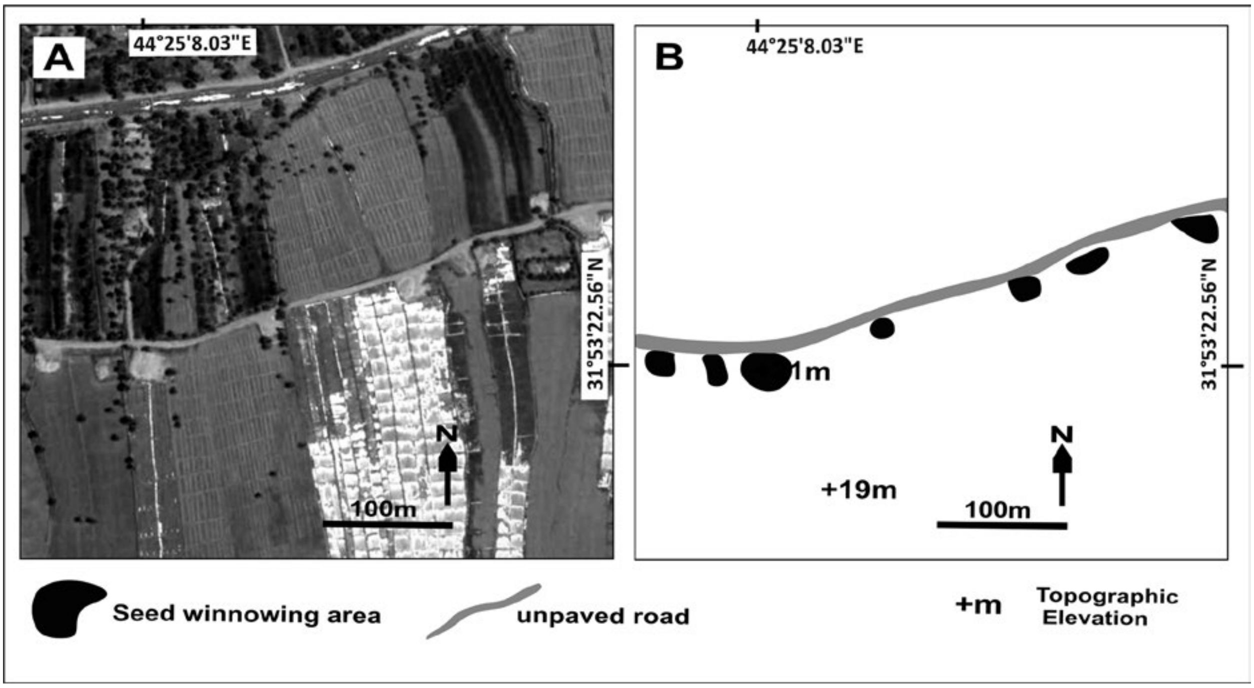

Figure 18.23. Potential pitfalls in the recognition of an archaeological site according to its size. (A) QuickBird image showing a seed winnowing area associated with an unpaved road southwest of Najaf city. It is not an archaeological site associated with a palaeochannel. (B) Sketch showing the identified features.

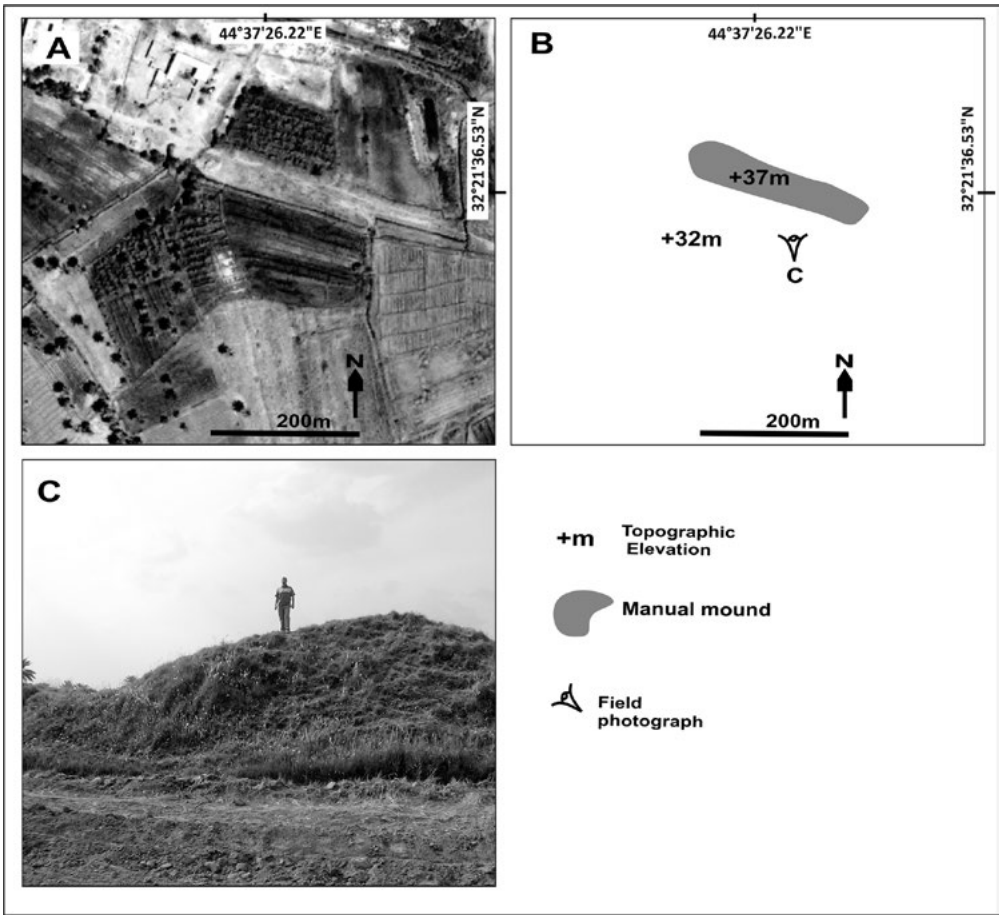

Figure 18.24. Potential pitfalls in the recognition of an archaeological site according to its size. (A) QuickBird image showing recent manually dug mound south of Hilla city. It is not an archaeological site. (B) Sketch showing the identified mound. (C) Field photograph showing the mound.

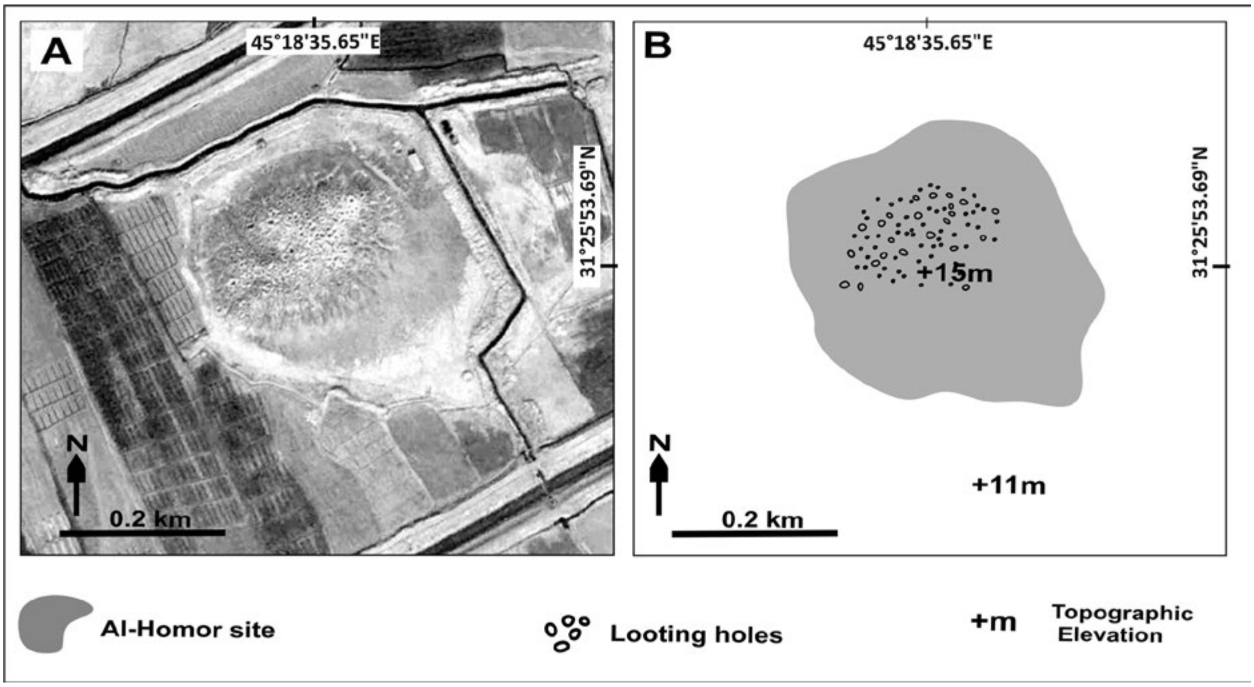

Figure 18.25. Recognition of an archaeological site according to situation. (A) QuickBird image showing looting holes on an archaeological site north of Samawah city. (B) Sketch showing the identified mound.

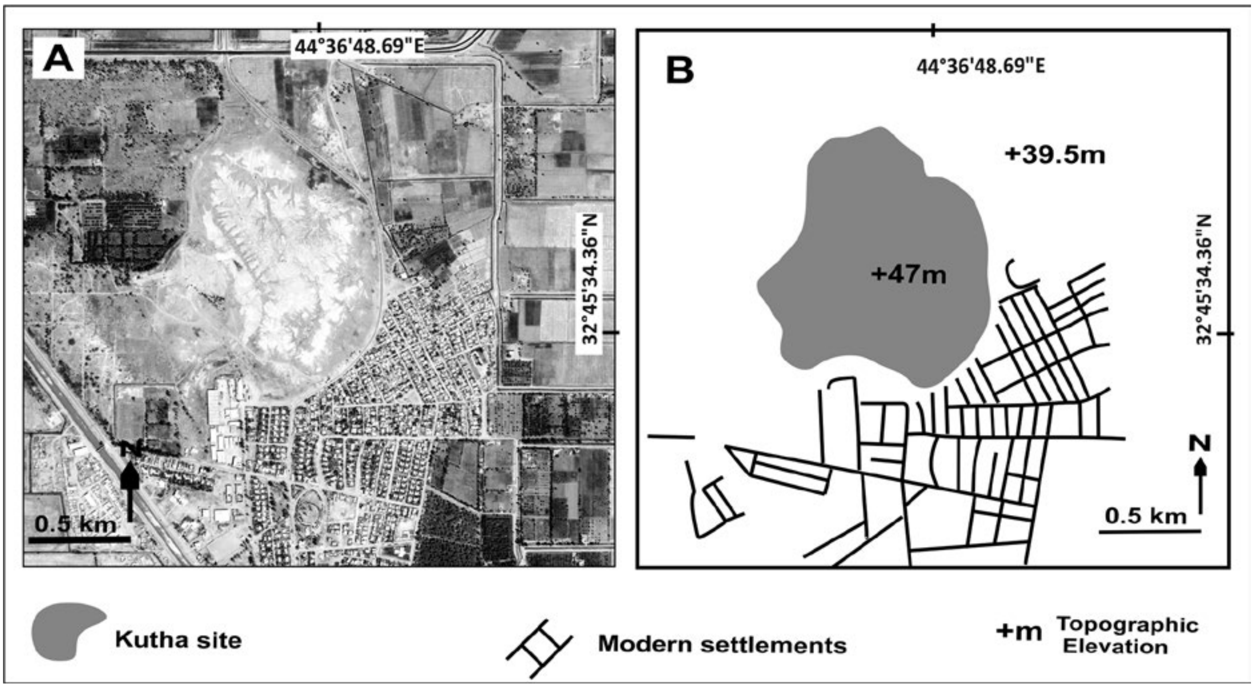

Figure 18.26. Recognition of an archaeological site according to situation. (A) QuickBird image showing modern urban development around an archaeological site northeast of Hilla city. (B) Sketch showing the identified mound.

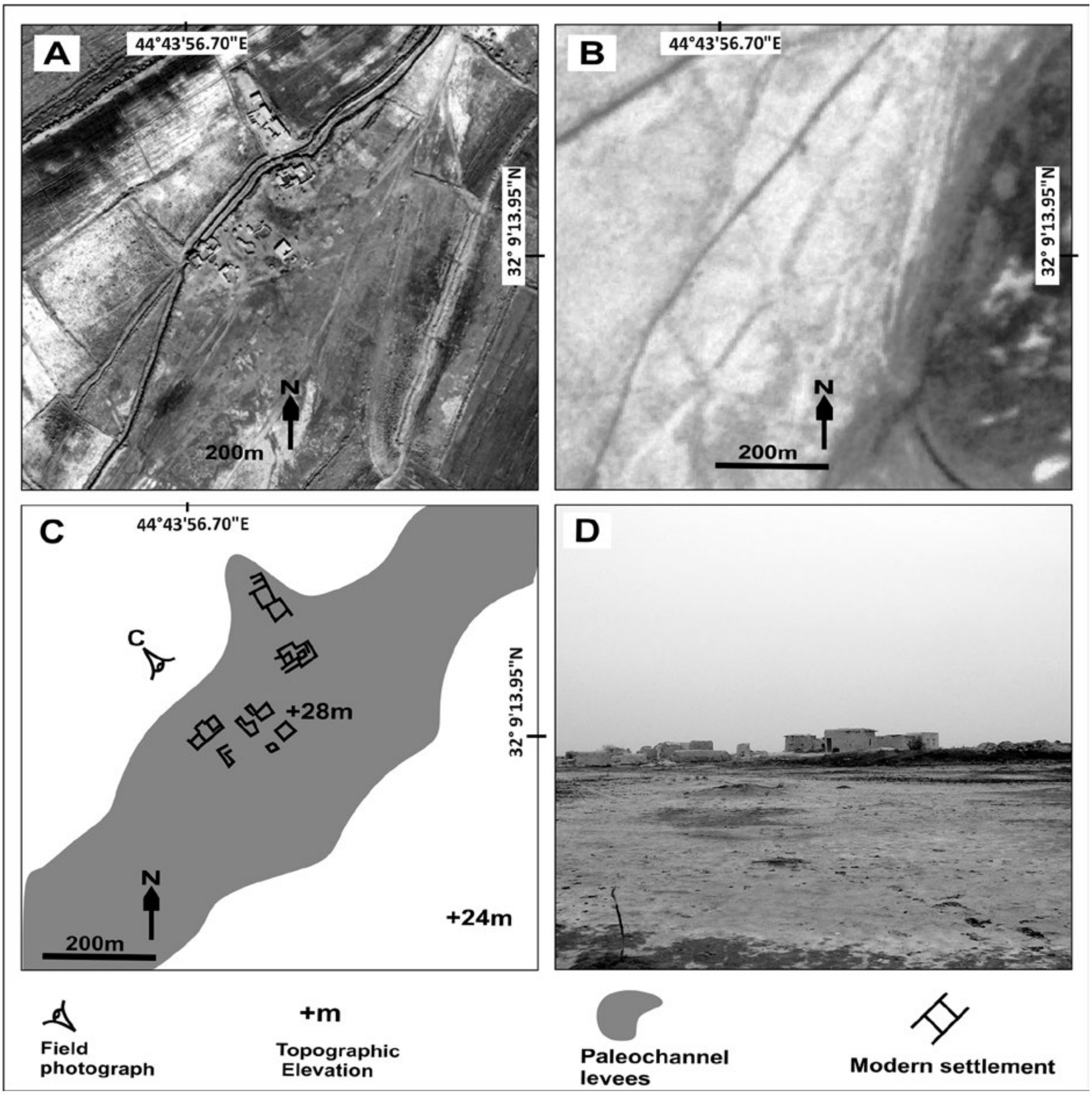

Figure 18.27. Recognition of an archaeological site according to situation. (A) QuickBird image showing modern development over palaeochannel levees north of Diwaniya city. (B) CORONA image for the same location before the houses were built. (C) Sketch showing the identified levee. (D) Field photograph showing part of this village and the palaeochannel levee.

2015). Seen in isolation, such splays may be misidentified as other kinds of channel; their relationship to the trunk stream makes their identification easier.

Case study

An area of 25 x 30 km has been selected (Figure 18.29) to illustrate the methods and criteria described in this paper. The area is located in the south of Iraq, to the north of the modern city of Nasiriya. It contains two famous archaeological sites, Lagash and Nina, both of which date from the Early Dynastic Period through the Ur III, Old Babylonian, Kassite, and Neo-Babylonian Periods. The other 12 sites date from the Parthian to Islamic Periods (Adams 1981; Hansan 1978).

What follows is an explanation of how the features described in the method section above were used to reconstruct the palaeochannel and archaeological sites in this case study. A first look at the SRTM of the case study area (Figure 18.29A) allowed us to recognise some elongated and ellipsoidal high topographic features. We interpreted these elongated features as channel levees and the ellipsoidal features as human settlements. In

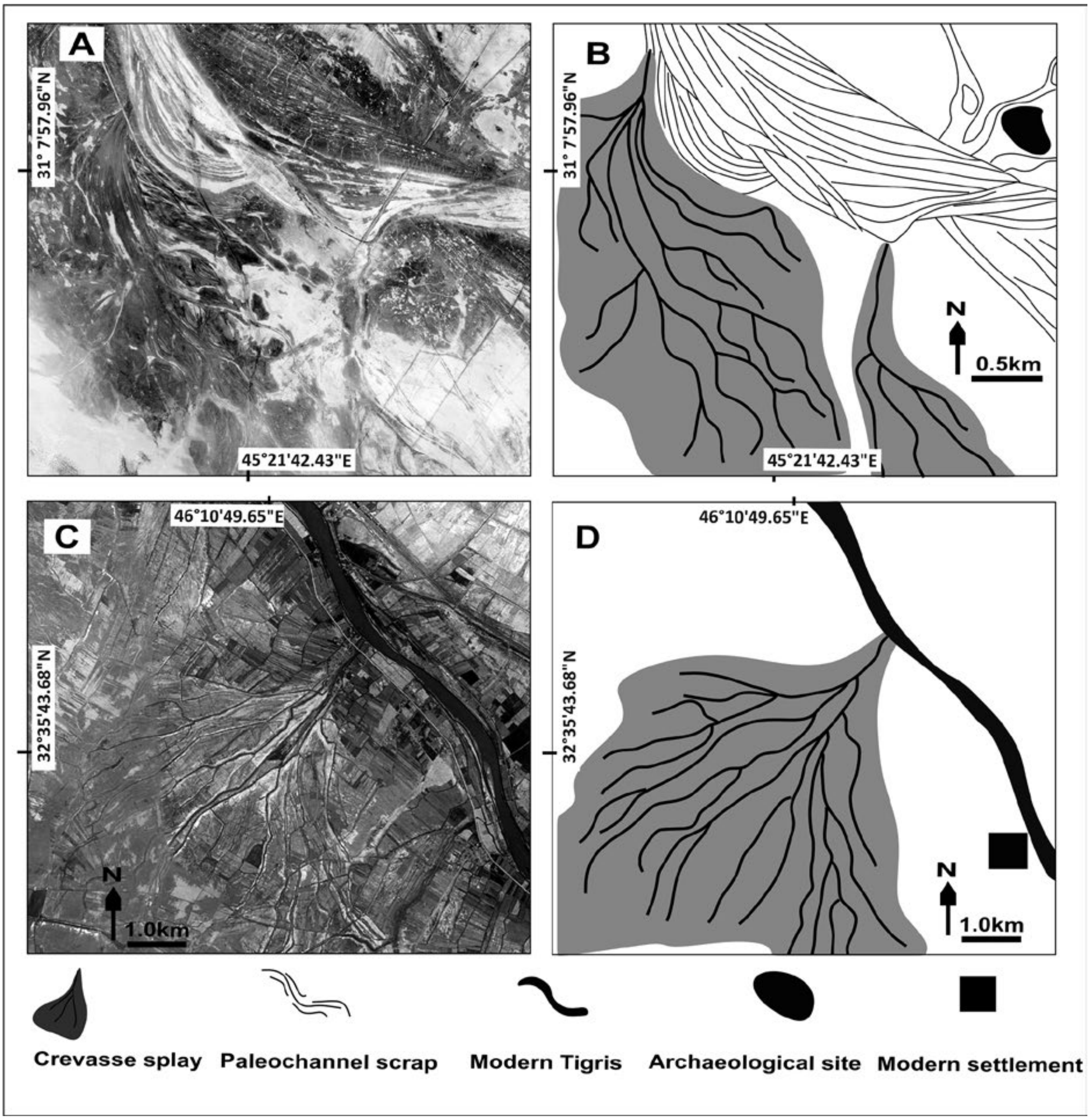

Figure 18.28. Recognition of palaeochannel according to situation. (A) QuickBird image showing crevasses splay associated with a palaeochannel west of Samawa city. (B) Sketch showing the identified features. (C) QuickBird image showing a crevasse splay associated with the modern Tigris River near Kut city. (D) Sketch showing the identified features.

order to clarify these features and find out whether they were modern or ancient, QuickBird images (Figure 18.29B) were used to trace the palaeochannels, archaeological mounds, modern channels, and marshes. The Lagash and Nina sites were large and it was easy to recognise them, but the other sites were small so some effort was required to distinguish them. Most of these sites are in a ‘herringbone’ alignment, indicating that they are associated with distinctive herringbone channels. The advantage of this alignment between sites and channels is that prospection in the field can be targeted to discover more sites and vice versa, i.e., looking for indications of channels around the line of the sites. Since the area is located in a relatively wet region, there is good relative tone brightness for features of relatively high elevation, i.e., sites and palaeochannels. Therefore, CORONA images were helpful. Most of the palaeochannels have well identified textures because the scrollbar features are very well preserved there.

As a result of tracing all the important features, it was found that there are two palaeochannels (known as

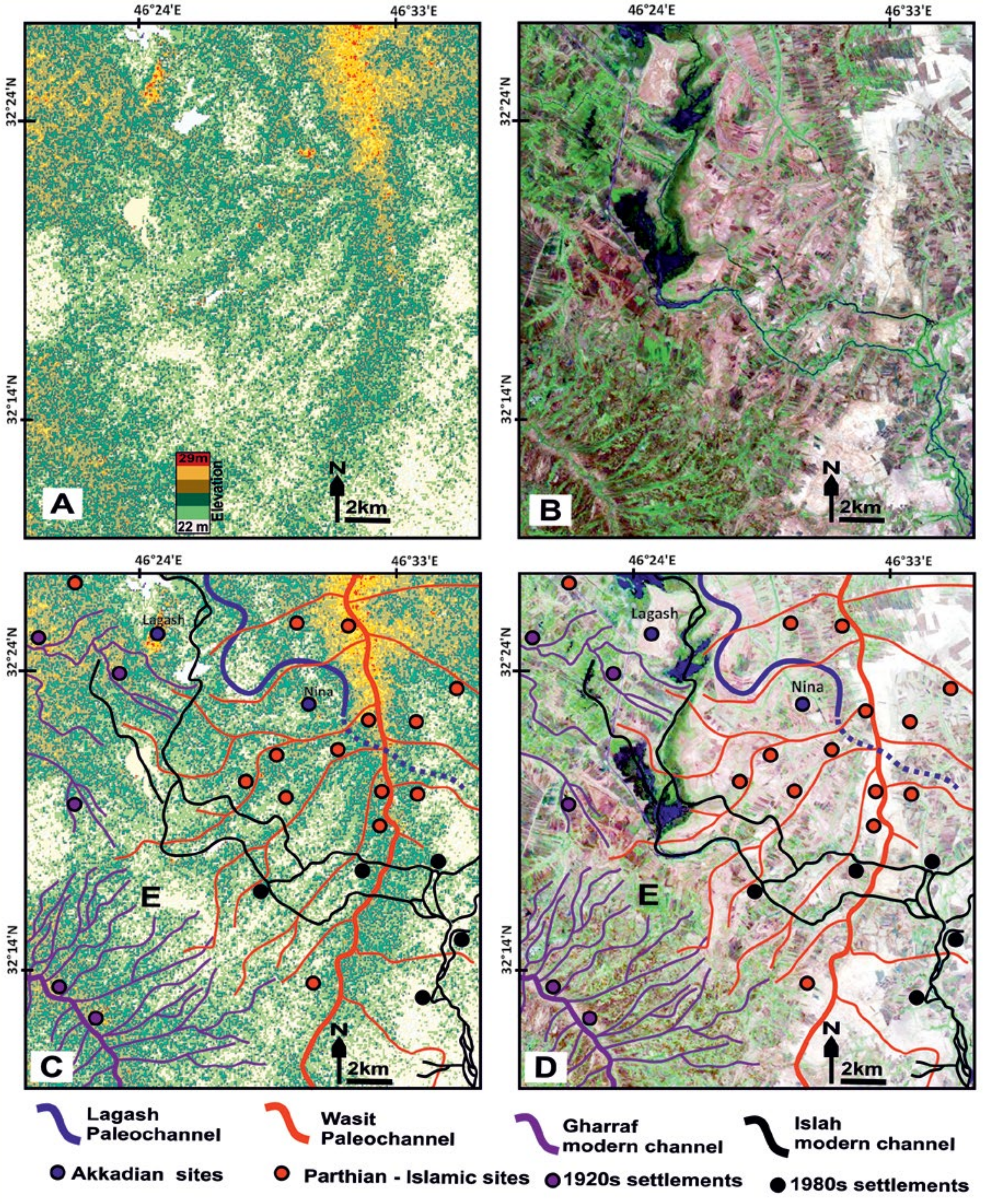

Figure 18.29. Case study showing tracing palaeochannel and archaeological sites north of Nasiriya city (see Figure 19.1). (A) SRTM data showing topographic relief of both modern and palaeochannel. (B) Landsat image for the same area. (C) and (D) tracing of the features on the SRTM and the Landsat respectively

the Lagash-Nina and Dujaila channels, associated with ancient settlements) and two modern channels (the Gharraf and the Islah channel running from the marsh) associated with modern settlements. However, a classification of the palaeochannels into a chronological order was attempted to provide a good indication of the relative age of the sites as well. Using the imagery it was possible to assess the stratigraphic relationships between the channels, since newer features clearly cut into older ones, and therefore to develop a chronological schema. The Gharraf distribution canals cut both the Lagash-Nina channel and the Dujaila channel. Additionally, the Dujaila channel cuts the Lagash-Nina channel, while the Islah channel cuts the Dujaila. Most archaeological sites associated with the Dujaila channel in this area were dated as Parthian, Sasanian, or Islamic in previous studies, such as those by Ur and Hamdani (2010). The fieldwork of the present study included taking samples from the palaeochannels for radiocarbon dating and groundtruthing of some small archaeological sites where the satellite images were unclear. The author intends to publish more results about the radiocarbon ages of this area and other areas in Southern Mesopotamia at a later date.

It is considered axiomatic that periods of active channels are closely linked to the ages of archaeological settlements and most of the identified ancient settlements were established on active channels (Adams 1981; Cole 1994). Four different periods of channels with four different settlements have been found (Figure 18.29).

The oldest palaeochannel is that associated with the sites of Lagash and Nina. The second palaeochannel is Dujaila, which is associated with the Parthian-Islamic sites. The third channel is the modern Gharraf branch and there are several modern towns associated with it. The fourth course is the Islah channel, which became active from around 1980 when the marshes started to dry up; drained water is continuing to gather in it. These results demonstrate that each channel was associated with a specific and defined period of settlement.

Conclusions

Over many millennia, humanity and nature have left their marks on the Earth in different ways, and always there are signatures for us to discover and use to interpret the past. The integration of geomorphological, geological, and archaeological data is the best method to understand the formation and evolution of the landscape of certain areas, and this is very much the case in Southern Mesopotamia where the surface is easily modified by natural and anthropogenic processes. It is important to use different types of satellite images and elevation data to form a better interpretation of surface features. However, using only remote sensing data does not produce a complete analysis, and needs support from groundtruthing, in this case through traditional fieldwork investigations. The wealth of new, high-resolution satellite imagery now becoming freely available, makes this an exciting time for archaeology, geomorphology, and neotectonic studies alike.

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Early Islamic Water Management in the Hinterland of Raqqa

Louise Rayne

Introduction and objectives

This paper presents the results of an investigation into the spread of water management systems in Northern Mesopotamia, during the Early Islamic Period, with a specific case study of the Balikh valley in Syria, an area in which Tony Wilkinson conducted a study during the mid-1990s. Water management was a topic of special interest for Tony Wilkinson since his earliest days of fieldwork in Iran (Wilkinson 1974), and this paper builds upon his integrative approach to the study of water within the archaeological landscape.

Early Islamic water management developed from earlier landscape changes and irrigation systems that had been intensifying since at least the Assyrian Period (early 1st millennium BC). By this time, irrigation systems had been constructed in most of the cultivable areas of Northern Mesopotamia; these comprised land alongside the Tigris and Euphrates, and systems abstracting from tributaries such as the Balikh and Khabur. In some locations, groundwater was extracted using qanats and other conduits.

The aim of this paper is to map this spread of irrigation activity in Northern Mesopotamia and in more detail in the Balikh. In order to achieve this, specific research objectives can be outlined:

1. How irrigation made use of the available water supply
2. How water management activity led to the imposition of changes on the landscape
3. How irrigation supported and enhanced the power of the Early Islamic Empire

Water management systems in Northern Mesopotamia developed in a different climatic and geomorphological context to the well-known canal systems of Southern Mesopotamia. Based on modern rainfall averages, the region is generally regarded as being within the zone of rain-fed agriculture (above 200–250 mm per annum — see FAO and UNESCO 1962; Wilkinson 1994: 484). This means that cultivation is possible without irrigation, which was the norm relatively recently (Beaumont 1996: 137). However, the averages obscure variability in rainfall totals. In many locations across the study region, a high proportion of years out of the last 30 received less than 200 mm (from GPCC data, see Schneider *et al.* 2011). For example, in the southern Balikh, only 13 out of 30 years (1981–2010, GPCC data) received 200 mm or more of rainfall. Variability indexes show that rainfall quantities in Northern Mesopotamia vary considerably from year to year (e.g., see Rayne forthcoming).

Proxy data indicate that conditions after the Bronze Age in the Middle East were dry (see Bar Matthews *et al.* 1997: 166) compared with the present day, although there have been climatic fluctuations (Bar Matthews *et al.* 1997: 166) It is possible, therefore, that variability may also have been an issue in the past. Irrigation offers an effective mitigation strategy to offset such variability.

Materials and methods

An interdisciplinary methodology (described in detail in Rayne and Donoghue 2018) was employed in order to facilitate fast mapping across a large area (circa 100,000 km^2). This research adopted the methodological approach of the Fragile Crescent Project of Durham University (see Galiatsatos *et al.* 2009), using remote sensing techniques along with existing archaeological surveys. The Table 19.1 outlines the main datasets.

The main resource used for identifying and mapping water features is historical satellite images (Figure 19.2), which were acquired at a time before the modern large-scale landscape changes had taken place. Dating to 1960–1972, and with a resolution of 2–5 m, CORONA encompassed several different missions; some of these missions produced better quality images than others, and some gathered stereo imagery that could be used for DEM creation using photogrammetry techniques. These properties of the imagery made it an ideal dataset for the present study (Rayne and Donoghue 2018).

The majority of images were obtained from the Fragile Crescent Project database (see Galiatsatos *et al.* 2009) and from the CORONA Atlas of the Middle East (see Casana *et al.* 2012), and had already been georectified by these projects. A few other images were obtained directly from the U.S. Geological Survey Earth Explorer service. In addition, newer images (see Table 19.1) such as Landsat were used for control for georectification and to examine how the landscape had changed.

DEMs (Digital Elevation Models) enabled validation of water features as artificial canals, making it easier to distinguish them from other linear features;

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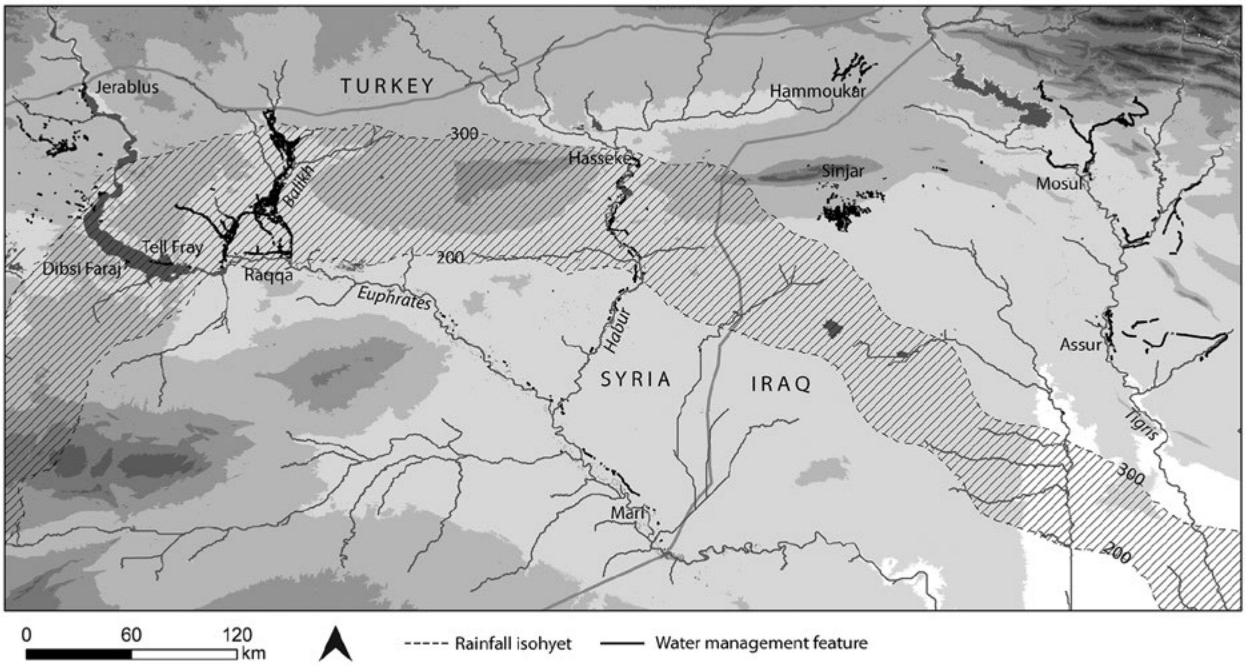


Figure 19.1. Water management features in Northern Mesopotamia were mapped from CORONA images in the present study. Some data was also contributed by Dan Lawrence, Niko Galiatsatos, the Fragile Crescent Project, Carrie Hritz, and Jason Ur.

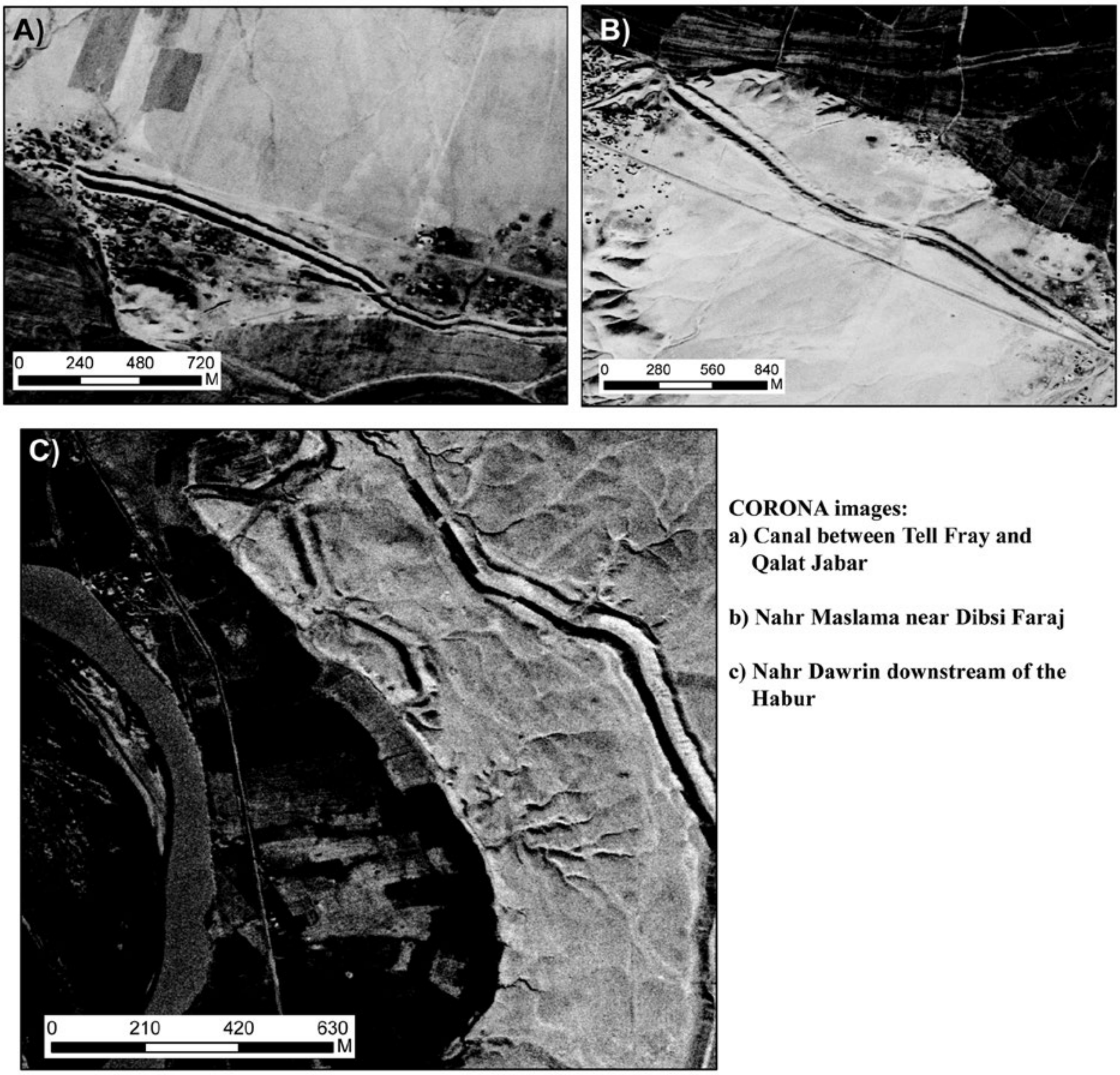
Table 19.1. Remote sensing data used to record ancient irrigation systems.

Dataset	**Sensor**	**Date**	**Resolution**
Images	CORONA (Missions KH-4A and KH-4B).	1967, 1968, 1969 1972	2–5 m
	GeoEye-1	2010	0.41–1.65 m
	IKONOS	2010	0.82–3.2 m
	Landsat TM, ETM	1984, 1990, 2000	
DEMs	SRTM	2000	90 m
	ASTER DEM	1999-2009	30 m
	CORONA	1968	c.10 m

canals tend to follow the contours of the landscape. The Shuttle Radar Topography Mission (SRTM) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) DEMs were used to characterise the topography in which each channel flowed, and also to generate networks of natural drainage so that these could be separated from the relict artificial features.

Archaeological surveys and fieldwork undertaken by the present study helped to validate features and gather GPS points and dating material. Existing published (e.g., Curvers 1991; Wilkinson 1998) and unpublished site surveys and excavations also helped to provide context. Much of this data was provided by the Fragile Crescent Project and Tony Wilkinson (pers. comm.), and included data about the locations and dates of settlement sites, water features, and geomorphological information. This was useful when, for example, the image interpretation process identified canals associated with a site described by survey data; the canals could be assigned the same date ranges as the sites. GPS points of features not clearly visible in the available imagery, for example in the Jerablus area, were collected by the present study.

Historical data was used in some cases to understand how specific irrigation systems functioned. For example, accounts by Arab geographers indicate who sponsored the construction of canals, and what crops were grown (e.g., see Le Strange 1930). Neo-Assyrian inscriptions



CORONA images:
a) Canal between Tell Fray and Qalat Jabar

b) Nahr Maslama near Dibsi Faraj

c) Nahr Dawrin downstream of the Habur

Figure 19.2. CORONA images of canals. Images A and B date to January 22, 1967. Image C dates to November 5, 1968.

have helped to date large-scale irrigation systems in Northern Iraq (e.g., see Bagg 2000; Jacobsen and Lloyd 1955) and early Islamic descriptions have provided key information about intensive irrigation (see Le Strange 1930). Some of the earliest evidence for irrigation in the region comes from documentary sources that attest to Bronze Age and Middle Assyrian irrigation in the Balikh (e.g., see Villard 1987; Wiggerman 2000).

Northern Mesopotamia

There is evidence for water management activity in Northern Mesopotamia that precedes the Early Islamic Period and shows development of large-scale irrigation systems at the time of the later empires (Neo-Assyrian to Early Islamic Period) (e.g., see Wilkinson and Rayne 2010; 2014). Some of the earlier data is Bronze Age and derived from botanical evidence (e.g., Jenkins *et al.* 2011) and historical texts (e.g., Bounni 1988; Villard 1987).

Powerful later states from the 1st millennium BC onwards constructed large-scale irrigation systems, relying on water from perennial water sources such as rivers and groundwater. In earlier periods, large rivers, such as the Euphrates, may have been considered difficult to abstract from (Van Liere 1963: 115) but later improvements in technology facilitated the construction of large-scale canals in these areas. Overall, as Figure 19.1 shows, water features are concentrated in river valleys and floodplains, while the steppe areas are relatively devoid of irrigation. Qanat-based irrigation extended out into more marginal areas where sufficient groundwater was available.

Using the interdisciplinary approach outlined above, the present study incorporated the evidence for later irrigation that could be located using remote sensing or ground-based mapping into one GIS database (Figure 19.1). The available evidence indicates that many of these features were constructed in, or at least reused during the Early Islamic Period. This evidence will now be reviewed.

The Euphrates has a mean discharge of about 1000^3 S^{-1}, with overbank flooding at some times of peak flow in the spring (Demir *et al.* 2008: 133). It may have been more difficult to control than its tributaries such as the Balikh and the Khabur (e.g., see Van Liere 1963) and periodic flooding would have damaged canals in the floodplain. However, by the Early Islamic Period, water management features were constructed alongside it.

In the northwest of the study area, several features were recorded in the vicinity of Jerablus. A 9–14 m wide canal alongside the Euphrates was dated to the Early Islamic Period (Wilkinson *et al.* 2007: 236). Rock-cut channels near the Early Islamic site of Khirbet Seraisat may have been contemporaneous with it, and could have supplied settlements and agriculture on the floodplain (Wilkinson *et al.* 2007). Additional rock-cut channels alongside tributaries in the Jerablus region, with possible Early Islamic phases, were recorded during fieldwork undertaken by the Land of Carchemish Project and the present study (Wilkinson *et al.* 2016).

Downstream of Jerablus, the fortified Late Roman–Early Islamic site of Dibsi Faraj was associated with a large canal (Figure 19.2B) and a qanat. The canal was recorded by Harper and Wilkinson (1975) during fieldwork and interpreted as the channel built by the Ummayyad general Maslama ibn Abdalmalik in the 8th century AD (Harper and Wilkinson 1975: 324); the qanat was identified using CORONA images by the present study (see Wilkinson and Rayne 2010). It is possible that the canal supplied fields on the floodplain and the qanat supplied the site with water for domestic purposes. Bringing water from above by gravity flow and transporting it in an underground tunnel would have been easier than lifting from the river below and would possibly have been more secure (cf. Resafa’s defences, which included protected water systems: Brinker 1991: 137).

On the opposite bank of the river to Dibsi Faraj, a large channel earthwork near Tell Fray (Figure 19.2A) has been dated to the Bronze Age on the basis of texts (Bounni, 1988: 369). However, analysis of CORONA imagery shows that it extends downstream towards the site of Qalat Jabar, where it fades out, suggesting a possible Islamic phase of use. This would have meant that large canals flowed at the margin of the Euphrates floodplain on both banks.

A detailed survey by Geyer and Monchambert (2003) identified a similarly intensively irrigated landscape downstream, recording traces of canals on both sites of the Euphrates between Deir ez-Zor and Mari. The present study used CORONA to locate these features. It was suggested (Geyer and Monchambert 2003) that several of these had Early Islamic phases of use. This included the significant earthworks of the Nahr Said and the Nahr Dawrin (Figure 19.2C). These were large canals, presumably capable of transporting large volumes of water; the Nahr Dawrin, for example, was around 30–60 m from bank top to bank top, based on analysis of the CORONA images.

Irrigation features of this period were also recorded in Northern Iraq, alongside the Tigris and its tributaries. This includes some of the canals closer to the Upper Zab (Altaweel 2008: 118), others near Kar-Tukulti-Ninurta (Altaweel 2008: 76) and the Tarbisu canal (Ur 2005: 332–333). Ur *et al.* (2013) recorded irrigation systems to the east of the Tigris, some of which they dated to the Sasanian–Early Islamic Periods (Ur *et al.* 2013: 106). A medieval 12th century description by Ibn Jubayr mentions irrigation using waterwheels near Mosul (Le Strange 1930: 89).

While much of the irrigation summarised here consisted of open-channel systems, qanat and tunnel based irrigation can also be identified throughout Northern Mesopotamia. The present study mapped an area of dense subterranean irrigation on the Sinjar Plain, radiating outwards from the site of Sinjar. Some of these are probably qanats taking advantage of an area of raised groundwater, while others may be tunnels transporting spring water.

There are several sources noting qanats on the Sinjar plains, although they do not discuss them in detail (see Al-Sawaf 1977; Cressey 1958; Fuccaro 1994; Lightfoot 2009; Ur 2013). Al-Sawaf (1977: 48–50) recorded and mapped some of the long-abandoned qanats in the area; Fuccaro’s historical thesis (1994) attributes the qanats to the Medieval (Early Islamic) Period, suggesting that they went out of use by the Ottoman Period (Fuccaro 1991: 12). Literature dealing with the layout of the Sinjar qanats is sparse; it is necessary to rely on CORONA satellite images to verify their existence.

The CORONA images (Figure 19.3) show complex networks of conduits covering much of the landscape in this area, some of which have connecting branches and

Figure 19.3. CORONA image of the Sinjar Plain qanats. December 11, 1967.

associated open channel systems. Several sites and field systems may also be contemporary with the qanats (see Figure 19.4). These are small, walled enclosures, often surrounding settlements, incorporating open channels that stem from qanats/tunnels. Hollow ways/tracks link the settlements. Although the Sinjar Plain does not have a perennial river, effective use was made of groundwater sources in order to create an intensively irrigated landscape. This would have enabled the cultivation of crops and possibly also the use of water mills (based on information from medieval sources discussed by Fuccaro 1994: 11–12).

The tributaries of the Euphrates were also irrigated during the Early Islamic Period. While traces of large canals along both banks of the Khabur were probably constructed in the Middle Assyrian Period (Ergenzinger and Kühne 1991: 166–178; Van Liere and Lauffray 1954–5: 117), they may have continued to be in use into the Early Islamic Period (Ergenzinger and Kühne 1991: 163). The canals are identifiable in the CORONA images; like many of the Euphrates canals, they consist of prominent earthworks in some places and have been removed by later human activity/the action of the river in others. It is not clear however if they form single extant systems on either side of the river. Traces of offtakes in some places suggest that they were used for irrigation. Arabic texts describe cultivation of gardens and of crops such as cotton on the Khabur (Ibn Jubayr, in Le Strange 1930: 95; Mustawfi, in Le Strange 1930: 97). Similarly extensive irrigation was practiced in the Balikh; given the density of data for the Balikh Valley, it will be discussed in more detail below.

Balikh Valley

The Balikh Valley (see Figure 19.5) was intensively cultivated during the period of the later empires, which used their political and economic power to impose and encourage irrigation. Archaeological survey (e.g., see Akkermans 1993; Wilkinson 1998) has recorded settlement throughout the valley, comprising some significant sites as well as more dispersed farmsteads. While there is textual evidence for Bronze Age irrigation and archaeological data for Hellenistic canal systems, water management was most intensively employed during the Early Islamic Period.

Investment in irrigation was already attested in the Ummayyad Period (Heidemann 2011: 47). In the south of the Balikh Valley, Raqqa had been at the frontier of several empires, including the Seleucid and Byzantine (e.g., see Challis *et al.* 2004). It attained increased importance in the Early Islamic period, under the caliphs al-Mansur and Harun al-Rashid: for a brief time under Harun al-Rashid it was the centre of the Abbasid Empire. It consisted of two settlements that were originally separate entities (Raqqa and al-Rafika). Ancient Raqqa probably overlies the Hellenistic Nikephoriom and Seleucid Kallinikos; Rafika (which is the centre of modern Raqqa) is the wall-enclosed town to the west, built in the Early Islamic Period (e.g.,

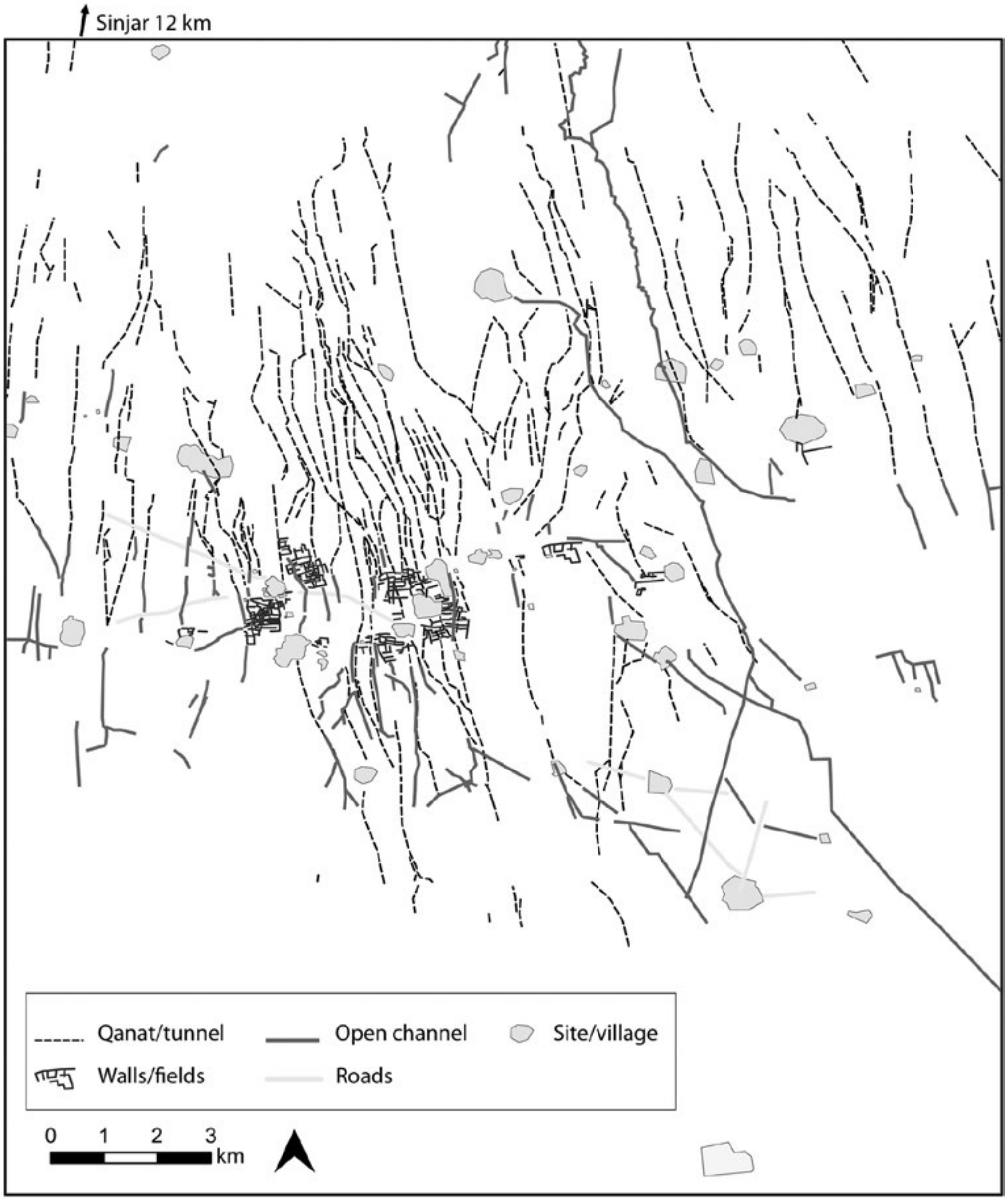


Figure 19.4. The qanats are part of a dense landscape of sites, fields and water management.

see Challis *et al.* 2004: 130). However, the whole area eventually came to be known as Raqqa, and consisted of settlements, palaces, and industrial areas.

Upstream, other significant Early Islamic sites are Medinat al-Far and Khirbet al-Anbar. The large Early Islamic site of Medinat al-Far may have functioned as a way-station and garrison in the Abbasid Period (De Jong 2012: 520). This was a prominent, walled site of around 124 ha (Bartl 1994: 221). At around 56 ha, the Early Islamic site of Khirbet al-Anbar is also one of the largest sites in the Balikh valley.

The geomorphological and hydrological context of the valley also offered opportunities for expansion through cultivation. The river valley forms a narrow corridor of alluvial, cultivable soils (Mulders 1969; Wilkinson 1998) between the Turkish Harran Plain in the north and the Syrian part of the Euphrates in the south. The valley is bounded on either side by slightly more elevated lands of gypsum soils (see Mulders 1969). The largely spring-fed Balikh functions as a permanent water source, although over-abstraction in the 1990s caused it to dry up (Wilkinson, pers. comm.). Several streams also channel runoff from the steppe into the Balikh Valley, including the Wadi al-Keder and the Qara Mokh. Traces of palaeochannels show that the Balikh has avulsed in the past, possibly removing earlier canals. Overall, the Balikh offers the most reliable source for irrigation water, although the other streams, including channels

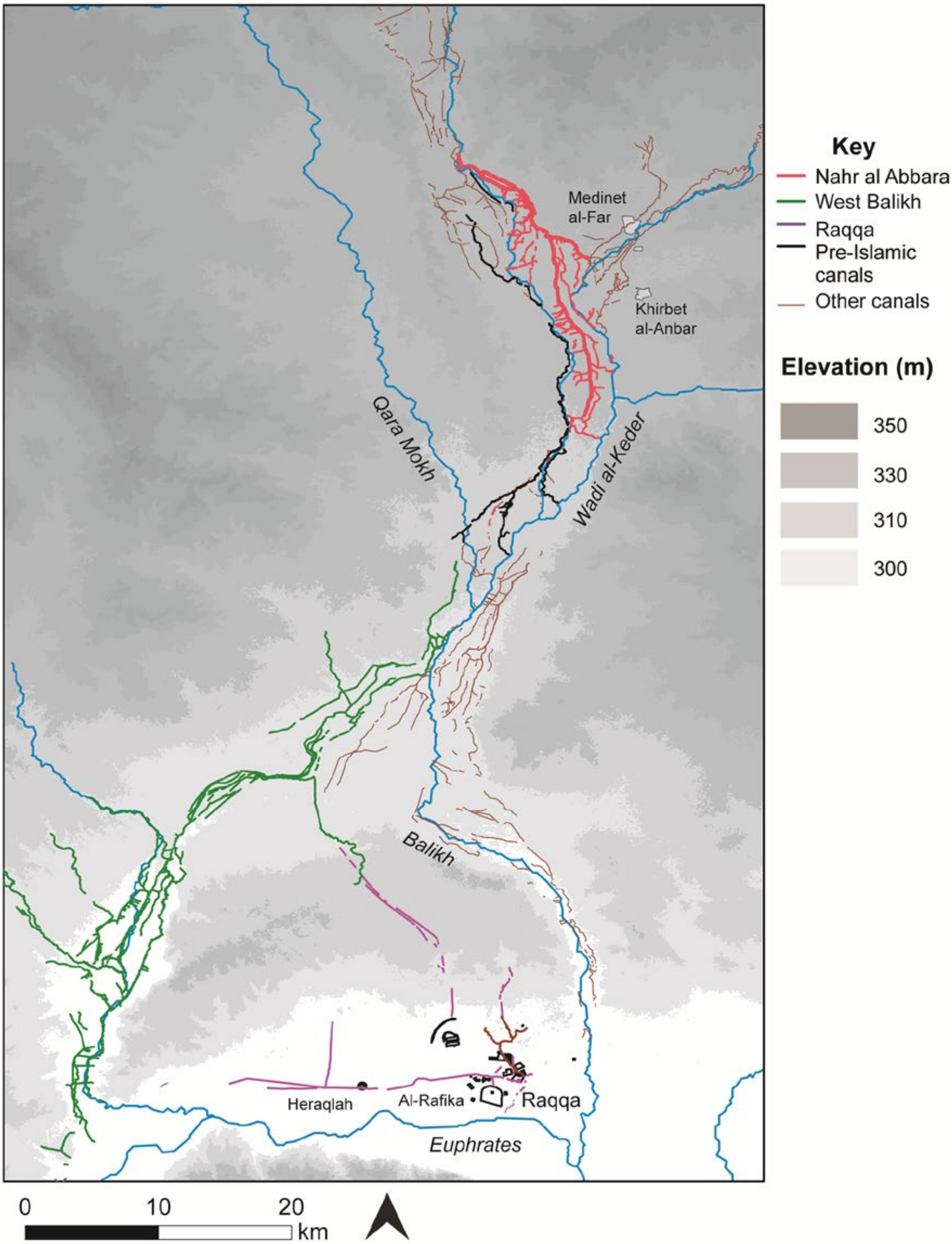


Figure 19.5. Map of the Balikh Valley

which only flow seasonally, also appear to have been incorporated into canal networks either as sources of water, as drains, or as attempts to control excess runoff.

Pre-Islamic water management

While the focus of this research is the Early Islamic Period, there is also evidence for earlier irrigation in the Balikh which can be summarised here (this is discussed in more detail in Rayne 2015 and Wilkinson and Rayne 2010). A document found at Mari refers to Bronze Age irrigation in the Balikh, possibly near Tell Hammam et-Turkman (Dossin 1974; Villard 1987; Wilkinson 1998). Data from Tell Sabi Abyad also indicates the presence of irrigation during the Middle Assyrian Period (Wiggermann 2000: 177). The first clear and mappable archaeological evidence, however, dates to the Hellenistic–Byzantine Periods. A large-scale canal abstracts from the Balikh near Tell Sahlan and flows south towards Tell Hammam et-Turkman. A section was excavated by Wilkinson (Wilkinson 1998: 71), and a sample from the bed deposits of the later phases of the canal provided a radiocarbon date of 1380+70 BP (Beta-78543); further traces of the canal were recorded using CORONA images by the present study. An extensive Hellenistic canal system downstream, which consists of a main canal, offtakes, and a drainage point, may have been connected to it (Rayne 2015; 2014; Wilkinson 1998: 77).

Islamic water management

Nahr Al-Abbara and Medinet Al-Far

The sophisticated Nahr al-Abbara canal system on the east side of the Balikh was identified by Wilkinson (1998) and dated to the Early Islamic Period (Wilkinson 1998: 68). The present study used CORONA to map it, showing rare preservation of an extant network comprising a main canal, lateral canals, and drainage points. During the 2010 field season the Nahr al-Abbara system was no longer identifiable. Instead, well-like structures along its former course indicated some form of subsurface irrigation.

Like the other nearby systems, it was constrained by the flat topography of the Balikh; it flows at a very shallow gradient of about 0.1%. At the same time, however, the designers of the canals ingeniously made use of the natural topography to create a very functional system. The main canal, which abstracts from the Balikh near Tell Sahlan, flows along a ridge of higher ground. An examination of the ASTER DEM (Figure 19.6) shows this almost imperceptible ridge (for more detail see Rayne 2015: fig. 5). Although the landscape is flat, making use of the ridge allowed the canal to supply a large area despite its shallow gradient. Sub-mains flow diagonally down the ridge, also with low gradients but enabling a larger area to be irrigated. The laterals flowed directly from the main canal perpendicularly down the ridge, giving them a steeper gradient of up to 0.5%. They are spaced at about 500 m apart. Limestone blocks along the main canal may have been part of former sluices (Wilkinson 1998: 68), which directed water into these laterals. Presumably farms and small settlements would have been located so as to take advantage of the lateral canals from which water could be delivered to the fields; there are, in fact, several sites close to these locations.

While this system was used in the Early Islamic period, it may have functioned over longer timescales. There are clearly two main canals of different phases of use running on contiguous alignments circa 400 m apart at the north end of the system; eventually the channels merge, indicating two separate phases of use on the same alignment. The main conveyor canal, visible on the CORONA images as a meandering channel, was still in use in the 20th century (Wilkinson 1998).

Based on the layout of the lateral canals, the irrigated area for this system must have been around 3600–4600 ha (although a proportion of this was probably under fallow during any one time). Water from the Balikh could have watered up to about 6000 ha, from the base flow of the Balikh (6 cu m/second: Wilkinson 1998: 81). The Nahr al-Abbara, therefore, could have been using a significant volume of the available water. This sophisticated and large-scale system would have required some organisation, possibly administered by the nearby site of Medinet al-Far. Early Islamic historical sources indicate irrigation in this area (Le Strange 1930: 105). These may refer to the Nahr al-Abbara and to some additional contribution, possibly seasonal, from other channels entering the system from the east, which may be modified natural streams (see Rayne 2015).

West Balikh

The western horseshoe, to the southwest of the Qara Mokh (see Figure 19.5), forms a basin between areas of more elevated land on either side. Examination of the satellite images shows that seasonal wadis flow into this area. So far it has been neglected by research, although recently Hritz (2013: 1978) has discussed geomorphology and settlement for this region. She suggests that a palaeochannel of the Balikh was located there (Hritz 2013: 1981). While a previous course of the Balikh probably shaped this region, some of the channels in the western horseshoe may be relict canals.

A set of parallel canals appear to abstract from the Qara Mokh, with channels joining these from the Balikh. These then merge into a meandering canal with a straight trace that flows towards the Euphrates before it is truncated by a former meander of the river;

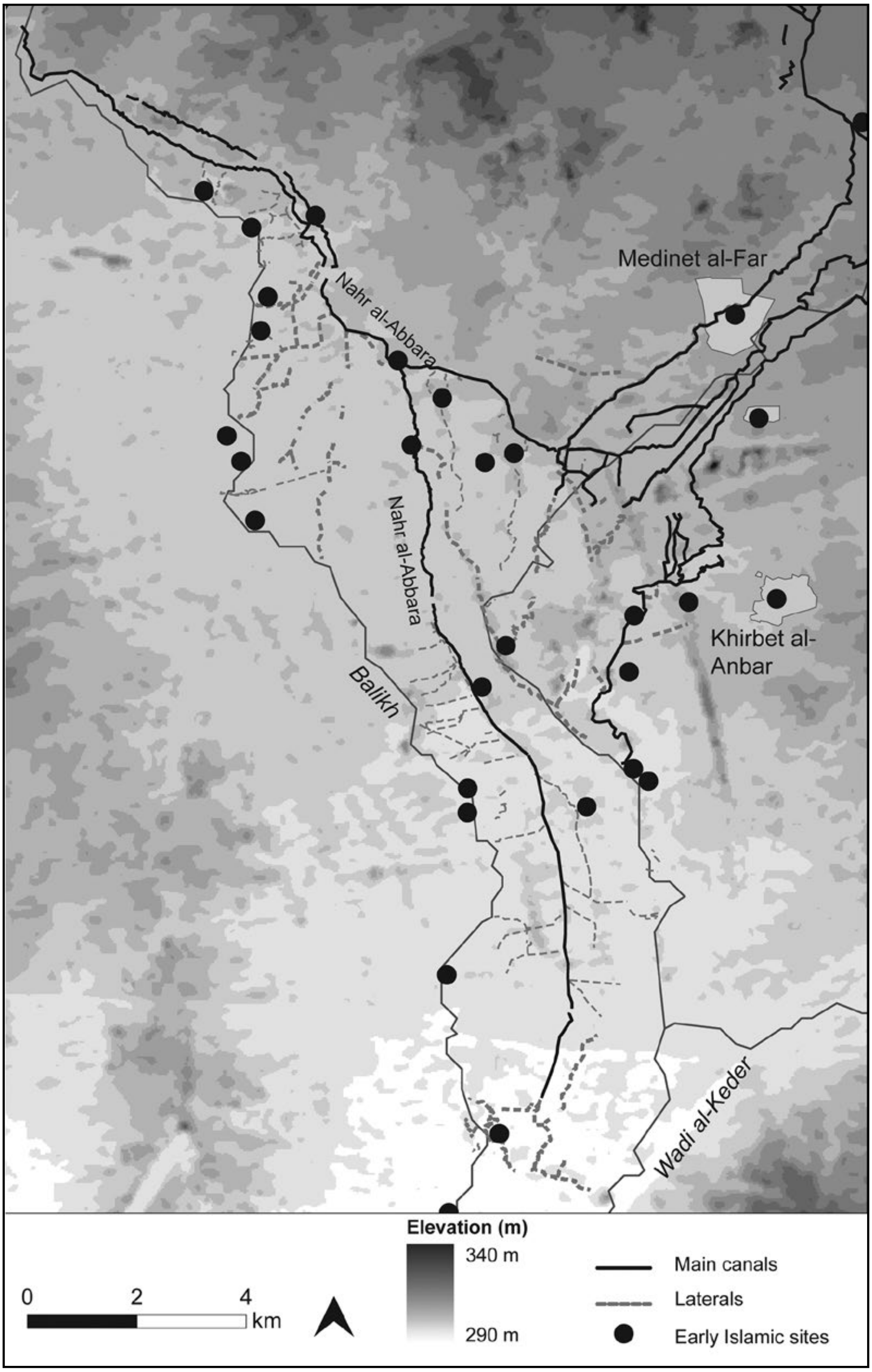


Figure 19.6. The Nahr al-Abbara canal system.

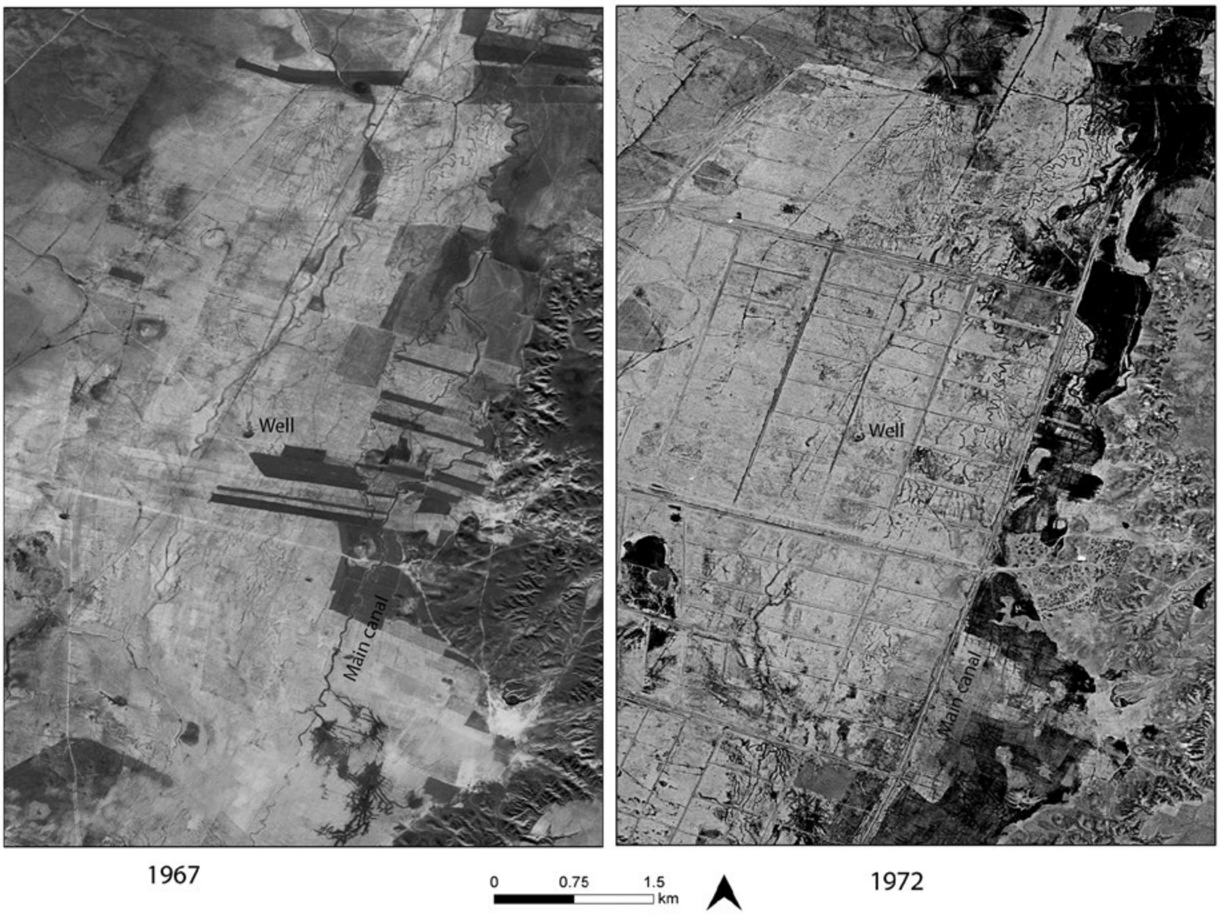


Figure 19.7. Canals in the western part of the Balikh horseshoe. CORONA images January 22, 1967 and May 16, 1972.

the whole system flows over about 50 km of land. The smaller relict canals are meandering and form a complex layout, indicating possible flooding.

Although this system has not been dated by survey and excavation, like the canal networks described above, some tentative dates can be suggested. As will be discussed below, at least one of these phases can be dated by a clear association with a subterranean tunnel. The tunnel diverts water from the Qara Mokh canals and terminates at the Early Islamic palaces north of Raqqa, visibly associated with these remains. This suggests an Early Islamic date for at least one phase of use of the Qara Mokh channels. The analysis of a time series of images indicates that the West Balikh canals are not modern (Figure 19.7). The 1972 CORONA image shows what appears to be a newly constructed grid of empty, dry canals being built throughout the western horseshoe zone. At the time of the earlier 1967 image, only a few of the new main canals in the south of the zone, near the Euphrates, had already been built. Given this, and the neglected appearance of the canals in the CORONA images, their final phases of use must pre-date at least the 1950s/60s; in addition, the area may have been less intensively settled and cultivated in the 18th–20th centuries (e.g., see Hole and Zaitchik 2006: 144; Lewis 1955: 60).

Raqqa and Heraqlah

The 1967 CORONA images enable the water supply that supported Raqqa to be identified. They reveal that Raqqa and the Abbasid palaces to the northwest of the city had separate water supplies. Between Raqqa and Rafika several canals flow through an Early Islamic industrial area. Although Heidemann interpreted these as Early Islamic features (Heidemann 2006), a long canal running west–east may at least post-date the early Abbasid Period. Based on historical accounts, Toueir suggests this canal was the Nahr al-Nil, constructed by the Abbasid caliph Harun al-Rashid (Toueir 1990: 217). On examining the CORONA images, and through fieldwork in 2010, it was found that it clearly cut through the walls of the early Abbasid site of Heraqlah; it was also clear that the canal was long abandoned and in a dry and eroded state. The upcast banks were about 1.5–2 m high, with a channel void about 10–12 m wide. The canal also overlies a sequence of layers of earlier channels (see Figure 19.5; Wilkinson and Rayne 2014). Two qanat traces truncated by the canal may be

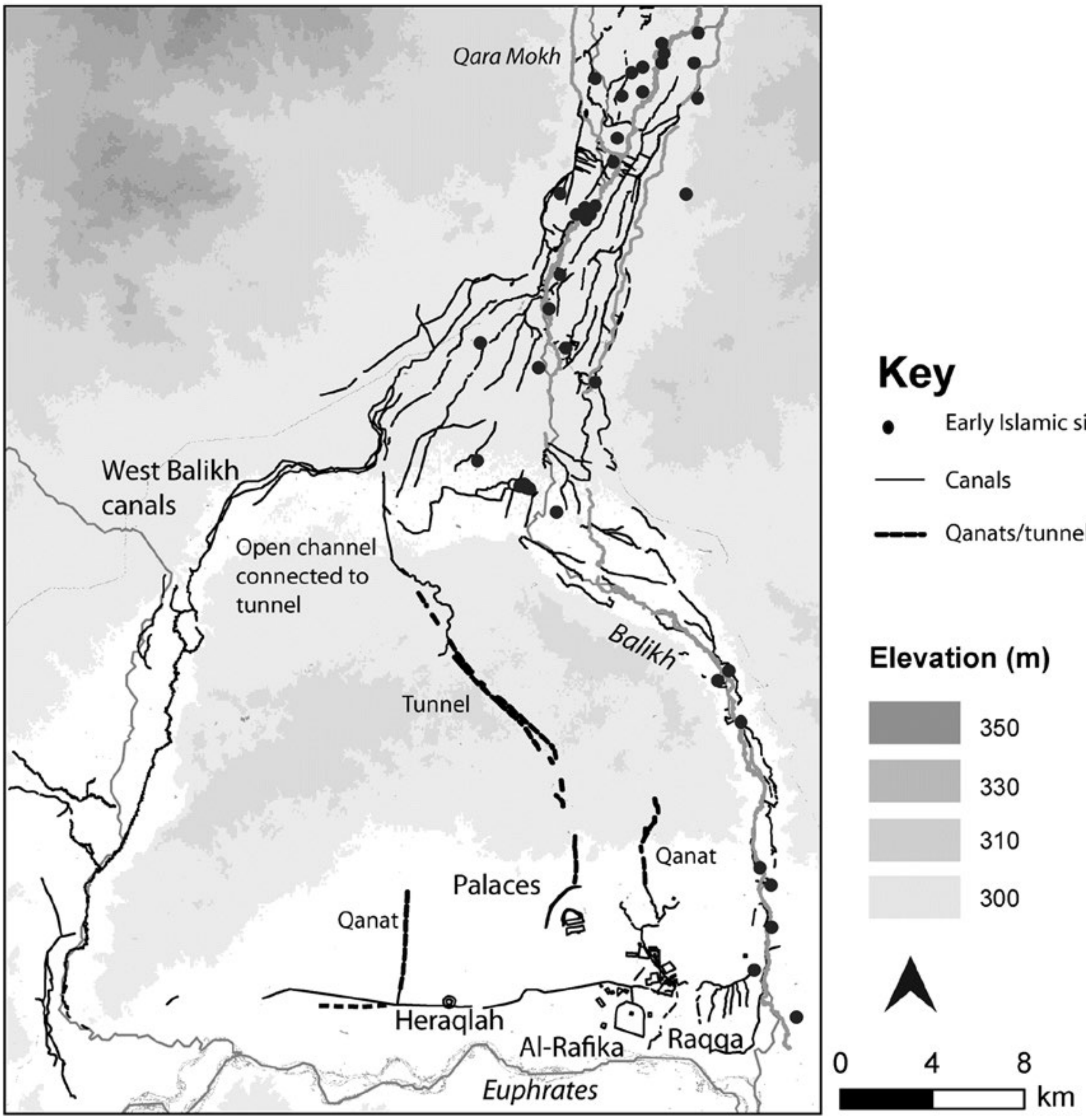


Figure 19.8. Irrigation features in the Raqqa area.

Umayyad (see Kamash 2009: 4). If the canal postdates Heraqlah, it may not be the Nahr al-Nil.

Aside from the post-Heraqlah canal, two other open channels flow into the Raqqa/Rafika area, originating from a qanat. The longer canal terminated in a depression which may represent the location of a former cistern. The other channel is more meandering, and only flows for circa 5 km before fading out in the vicinity of Tell Bi'a and presumably draining into the Euphrates. A fragment of another qanat can be seen just 1 km from the walls of al-Rafika.

Several palace complexes to the north of Raqqa have been identified on the CORONA images. A particularly large set of structures also interpreted as an Abbasid palace (Challis *et al.* 2004: fig. 2), is at the periphery of the Early Islamic palace complexes. The feature has similarities to other palaces of the same period, with components that may represent a racecourse and a hunting park (e.g., see Northedge's (2005) discussion of Samarra).

Significantly, however, this palace complex has its own water supply, separate from the qanat that feeds Raqqa and Rafika. This originates as an open channel (see Rayne 2015; 2014), connected to the west Balikh system of canals that abstract from the Qara Mokh. It then flows for about 25 km before reaching an obstruction in the form of an elevated area of land (see the DEM data in Figure 19.5).

In order to traverse this upland, the canal cuts straight through the higher ground, becoming a tunnel.

Maintenance shafts at the surface give the feature a ‘qanat-like’ appearance. There are known dated parallels for such tunnels, for example the Negub tunnel in Northern Iraq that supplied 9th to 7th century BC Nimrud (see Reade 1978: 171). However, in this case the associated archaeological sites suggest that the tunnel is Early Islamic. Once the higher ground is successfully traversed, it becomes an open channel again. Control structures in the form of cisterns are associated with it at this stage. Finally, the channel fades out within the hunting park/race course area of the Abbasid palace. It is possible that this channel could have been the Nahr al-Nil linked by Toueir (1990: 217) to the canal truncating Heraqlah.

Discussion

Datasets gathered using remote sensing techniques and legacy archaeological surveys revealed that many of the available water resources in Northern Mesopotamia were heavily exploited by the Early Islamic Period. The evidence for water management in the Balikh shows increasing activity from at least the Bronze Age, but especially in the period of the later empires with evidence for Middle Assyrian and Hellenistic irrigation (see above). The Early Islamic period represents a peak, when new large-scale and sophisticated systems were constructed in order to support the Abbasid economy with higher and more secure crop yields. If earlier systems such as the Sahlan-Hammam canal were still in use, most of the available water in the Balikh could have been abstracted (see Figure 19.5).

It seems no coincidence that the high point of water management in the Balikh occurred at a time when Raqqa was at the centre of the Abbasid Empire. The valley itself may have supported the imperial economy through a mixture of direct imposition and incentives. The state may have directly sponsored canal construction in the vicinity of key sites, including some in the Balikh. Wealthy individuals were encouraged to construct new canal systems, bringing formerly non-irrigated, and therefore ‘marginal’ lands into cultivation, through tax incentives (e.g., see Kennedy 2011: 181–182). The site of Medinat al-Far may have been built by a relative of the Umayyad caliph, who also sponsored irrigation in the area (see le Strange 1930: 105); it is possible that the Nahr al-Abbara was overseen by the site for the purpose of gaining taxes. Given that the Nahr al-Abbara could have irrigated around 3600–4600 ha, it would have offered the opportunity for considerably more secure yields than could have been obtained through reliance on rainfall or small-scale irrigation.

If the West Balikh system was in use in the Early Islamic Period, it may have used water from the stream of the Qara Mokh in order to mitigate against over-abstraction of the Balikh upstream (a problem which was observed in the 1990s by Tony Wilkinson). The topography through which it flowed may have limited it, allowing occasional, seasonal high-volumes of runoff to enter the palaeovalley and potentially damage canals; water could only be removed along the gradient line of the canals themselves. The Nahr al Abbara was able to use the Wadi al Keder both as a catchwater drain for runoff from the east, and also as a drain for irrigation water.

The city and palaces required water for domestic and industrial purposes, which were supplied by qanats and a tunnel. It would have been easier to bring larger quantities of water from above, by gravity flow, than to lift them from the Euphrates below. Raqqa’s function as an important industrial site (Henderson *et al.* 2005) may also have led to more demand for water.

The palaces could have been luxury consumers of large volumes of water. The possibility of parks and gardens as consumers of water elsewhere in Northern Mesopotamia should not be discounted. Landscaped features such as hunting parks and racecourses are known from Abbasid Samarra (e.g., see Northedge 2005; 2011); a viewing platform comprising a pavilion within the racecourse was indicated, surrounded by a moat fed by qanats (Northedge 2005: 156). Gardens have also been suggested for Samarra and other Abbasid sites (see Ruggles 1990: 183) including the palaces of high-ranking early Islamic individuals (e.g., see Decker 2011: 3).

Given this, it is possible that such viewing platforms were also a feature of the Raqqa palaces and could explain several circular structures in the vicinity of the palaces and racecourse. Heidemann suggests that Harun al-Rashid brought water to Raqqa partly to supply the palace gardens (Heidmann 2011: 49). This could have been a function of the tunnel system.

Historical sources show that other Early Islamic sites in the Balikh also had irrigated gardens. Le Strange cites these, indicating the presence of canal irrigation in the area around Medinat al Far (Le Strange 1930: 105). Heidemann (2011: 51) also suggests irrigated gardens in this area. This does serve as a reminder of the relationship between water and power; gardens are certainly a luxury use of water in a semi-arid environment, and are generally associated with high-ranking individuals.

As Figure 19.1 shows, irrigation activity can be indicated for most of the cultivable areas in Northern Mesopotamia dating to the Early Islamic Period. This appears to have expanded beyond patterns of earlier irrigation (e.g., see Wilkinson and Rayne 2010; 2014). Rivers like the Euphrates and its tributaries were exploited by canal-based irrigation, and elsewhere groundwater was used to irrigate lands without an easily exploited, perennial surface water source. This highlights the importance of the organising ability of powerful states in reshaping the landscape. Constructing large-scale canal systems like the Nahr al Abbara would have changed existing hydraulic routes and resource management strategies; enforcing this would have the potential to cause conflict.

Despite this, the increased crop yields facilitated by irrigation would have supported and strengthened the economies of the later empires. The expense and administration required, as well as the need for enforcing landscape changes, would have served to demonstrate the empire's power. In conclusion, by integrating information obtained from multiple sources including archaeological surveys, remote sensing, and historical accounts, it is evident that water management in Northern Mesopotamia reached a peak in development and density during the Early Islamic Period. This happened in the Balikh at the same time that Raqqa was the centre of a powerful and extensive empire. The presence of the Abbasids was significant, with the state possibly having a direct role in sponsoring canal construction and modification. Moreover, it is clear that while the Early Islamic state built on earlier systems, choosing the same locations and re-using some channels (for example in the Khabur), it was also able to impose new, more extensive water management systems on the landscape.

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Conclusion

Dan Lawrence, Mark Altaweel and Graham Philip

In reviewing a volume inspired by another archaeological luminary, Randall McGuire (2014) identifies two problems with the *Festschrift* genre. First, in attempting to reflect the interests of the individual scholar being honoured, such volumes become rather disparate collections of essays lacking thematic coherence. Second, the emotional and political implications of picking and choosing contributors and editing contributions result in a decline in overall quality. We have tried to mitigate these problems in this book by focusing on a relatively narrow topic and by inviting contributions from Tony's students and project collaborators rather than a selection of the great and the good. As a result, the volume does not do justice to the extraordinary scope of Tony's scholarship and expertise, which ranged geographically from the UK to Southern Arabia and Iran, and temporally from the Neolithic to Medieval periods. Rather, the contributors were asked to celebrate a particular aspect of Tony's work, his pioneering use of remote sensing and large-scale datasets in landscape archaeology, in the hope of producing a more useful final collection. This concluding chapter seeks to draw out some of the emergent themes of these contributions and to suggest what new agendas in remotes sensing and landscape archaeology in the ancient Near East might look like.

Prospection and site mapping

Much has changed since the early days of landscape archaeology as applied to the Near East (for a useful overview see Hritz 2014). When Tony first began to work in the field during the 1970s and 80s, the tensions resulting from the Cold War meant that it was difficult to obtain detailed maps, let alone remote sensing data such as aerial photographs. Landsat satellite data were available by the early 1970s, but offered very coarse resolution (initially over 80m (Heaslip 1977), although resolution of 30m was available by the 1980s), and were used for land cover mapping as much as the detection of individual sites and features. That said, Landsat imagery played a role in site location during Tony's North Jazira Project in the late 1980s, although this was not widely publicised at the time. The real step-change occurred in the late 1990s and early 2000s with the declassification of CORONA and the growing availability of commercial high resolution and multispectral satellite data. Increased computational capability, the availability and higher accuracy of GPS devices, and improved spatial databases and analytical software such as GIS platforms, and of affordable hand-held computers that could be taken into the field, also played an important role. Taken together these innovations served to make what were once highly technical, laboratory-based techniques accessible and affordable to archaeological field teams. Much of the initial landscape work to make use of the new remote sensing data sources was highly empirical, focusing on defining and recognising sites and features in the landscape, both as an end in itself and as a way of enhancing traditional methods of Near Eastern survey. Remote sensing also facilitated a renewed interest in off-site features, including traces of water management and route systems which were relatively easy to identify on CORONA but often ephemeral or destroyed in the field. Such methods were not new as such, having been pioneered by Adams and others using aerial photographs in Southern Mesopotamia from the late 1950s (Adams 1981), but the massive increase in coverage of the new datasets was certainly transformative. In some areas, such as the lowlands basins of Syria, it quickly became clear that almost all known types of archaeological site were visible on the imagery, meaning the search for new sites could be largely driven by prospection through remote sensing (see Philip *et al.* 2005; Casana and Wilkinson 2005; Ur and Wilkinson 2008; Ur 2010). By demonstrating that the technique was able to recover a large proportion of the ancient settlement record, these projects served to disarm a somewhat skeptical survey research community, and allowed archaeology in the Middle East to continue to pitch its landscape projects at a relatively large scale, resisting the trend in adjacent areas, such as Cyprus and the Aegean, for the ever more intense field-walking of increasingly small study units. In some respects, the emergence of remote sensing permitted Near Eastern archaeology to side-step the kind of 'small but perfectly formed' projects that both Blanton (2001) and Kowaleski (2008) viewed as having undermined the ability of researchers to address large-scale questions. More than a decade later, this methodology has become the norm in much archaeological survey work, as demonstrated by the flurry of projects currently underway in Iraqi Kurdistan.

The increasingly efficient recognition and documentation of sites is to be applauded, and represents a major contribution to landscape archaeology. Furthermore, the scope for continuing empirical work of this nature is enormous; the Near East is a vast geographical area and there are many parts which have not been sufficiently studied either in the field or remotely, for political, academic, logistical or happenstance reasons. However, there are clear areas where these sorts of approaches could be improved. It is somewhat remarkable to note that we are still not entirely sure why certain archaeological sites and features are visible on certain types of imagery, and that this fundamental subject has received relatively little attention. This is particularly true of un-mounded sites which show up as soil discolourations on the imagery and are frequently Iron Age or later in date. The few analyses which have been conducted suggest that some combination of particle size, soil moisture and mineral composition are all involved (Wilkinson *et al.* 2006; Beck *et al.* 2007) but we do not as yet have a series of general principles for understanding the causes of reflectivity in, and consequent visibility of, anthropogenic signatures. Developing such principles is vital in order to understand where different sorts of remote sensing will be most effective, assess what is missing from the record and examine the relationship between site extents in the field and on the imagery. CORONA imagery has, for example, proved relatively effective at detecting sites in upland landscapes in Syria where the building stone is predominantly volcanic (Philip *et al.* 2007) but less effective in areas where both structures and bedrock are limestone, as well as for recognising low, shallow-sided tells in Azerbaijan (Ricci *et al.* 2018) and Turkey (Lawrence 2012). This is almost certainly attributable to variations in the degree of contrast between the reflectivity of the various elements appearing in the image in different parts of the electromagnetic spectrum (Beck and Philip 2013).

Assessing the relative utility of imagery in different types of landscapes is also hampered by the absence of clear methodological descriptions of prospection techniques within publications, and the frequent identification of features through the visual inspection of imagery that has been subjected to a ‘standard’ transformation, when other methods of image manipulation might produce additional insights. Just as in archaeological survey, the amount of time and labour expended per unit area in examining an image, alongside other factors such as user experience and sampling techniques, will have a profound effect on the quality and quantity of archaeological information recovered, and yet these are rarely discussed explicitly, let alone considered from a cost-benefit perspective. Similarly, although recording the number of false positives (sites identified on imagery which when visited in the field prove not to be archaeologically relevant) is standard in predictive modelling of remote sensing datasets (Kwamme 2006), this is not the case for more qualitative interpretation methods, although these data were recorded by the Durham field team working in the Homs region of Syria (Philip *et al.* 2005). Collating this sort of information at a regional scale would give us a much better understanding of the relative effectiveness of our current approaches in different areas, allowing us to identify what may be missing from the archaeological record.

Broadening the scope of the discipline

A welcome recent trend in remote sensing and landscape archaeology in the Near East has been the willingness to move beyond simply describing the landscape and to engage with questions of interest outside the discipline. Given the bewildering array of data sources becoming available, complexity theory (Bentley and Maschner 2003; Kohler 2012) represents a promising theoretical strand because it integrates disparate data sources and examine how interactions between social and environmental variables, even at different scales, obtained from archaeological research can enhance our understanding of settlement and past land use. Beyond complexity, concepts such as human niche construction (Kendall *et al.* 2011) and resilience (Redman 2005) provide useful ways to look at human and environmental dynamics holistically and to move beyond simple deterministic hypotheses (Butzer and Endfield 2012).

Discussion around collapse and resilience brings us to palaeoclimate studies. Despite the growing wealth of data, and its obvious potential for understanding the human past, archaeologists have been rather reticent about engaging in these debates. This we attribute to the small-scale focus of most archaeological research projects which typically work on a single site or local area (for comment on a similar situation within the discipline of history, see Guldi, and Armitage 2014). However, disciplinary specialists also have a clear sense of the limitations of the archaeological evidence. Accordingly, the ‘high level’ debates have mainly been conducted by specialists in other fields, who have not always been cognisant of these issues. For example, claims that episodes of rapid climate change engendered major economic transitions and political disruptions (e.g. Staubwasser and Weiss 2006; Weniger *et al.* 2006), have not generally been borne out when the archaeological evidence is accorded detailed scrutiny (e.g. Flohr *et al.* 2015; Maher *et al.* 2011). A recent study (Clarke *et al.* 2016), has both argued that periods of high climatic variability may have been as important for driving change as unidirectional shifts, and demonstrated the degree to which local responses to just such an episode during the 4th millennium BC, differed according to their particular affordances and pre-existing social organisation.

While some very broad connections between climate and settlement can already be delineated at a regional level (Lawrence *et al.* 2016), interpretation is complicated by spatially divergent responses to what appear to be very clear climatic signals. The contrasting settlement trends in the northern and southern Levant (Wilkinson *et al.* 2014) during the later 3rd millennium BC, contemporary with a phase of growing aridity documented at Soreq Cave (Bar-Matthews *et al.* 2011), is a case in point. Additionally, the pollen evidence from from lakes in the Rift Valley does appear to reflect a unidirectional gradient (Langgut *et al.* 2015), hinting at the protean ways in which climate change could play out at the very local level in which most human experience was shaped.

It is clear that the growing breadth and depth of settlement datasets, created by augmenting field results by remotely sensed information are allowing us to ask new questions, as seen in the contributions of Rey and Lawrence and Smith. While the creation of large datasets will require new ways of comparing and integrating data collected by projects with quite distinct aims and methodologies, the potential of a large-scale approach has recently been demonstrated by an analysis of some over 50,000 sites in China spanning 8000–500 BC (Hosner *et al.* 2016) and which brings out major regional and temporal trends in settlement intensity. Our aim should be to offer a settlement-based account of long-term developments in the ancient Near East, one that can be interrogated at both local and regional scales, and that will provide a lens through which to examine critically the reliability of reconstructions of the past which draw largely upon the extant documentary sources.

The integration of remote sensing techniques and landscape archaeology with other data types is a theme that features in a number of papers. Those by Rey and LeCompte, Rattenborg and Brown make extensive use of textual sources to address questions relating to individual sites, settlement patterns and societal organisation. While analytical approaches allow us to make sense of disparate data, the layering of information from historical sources and remote sensing provides us with a way to identify features mentioned in texts, and better understand them. Environmental techniques are also becoming increasingly relevant, and the papers by Marsh and Altaweel, Jotheri and Allen, Hritz and Pournelle and Stone combine heavy use of remote sensing with detailed geomorphological studies and even phytolith analyses, and reveal that extent to which past environments may have differed quite significantly from, and thus offered opportunities at variance with, those documented in more recent times. Environmental approaches predominate among those papers concerned with Southern Mesopotamian, perhaps because of the importance of canals and other irrigation features visible on the imagery to understanding this highly complex landscape. The recognition and interpretation of water management systems represents one of the most fruitful areas of research for remote sensing in the Near East, as is evident from the papers by Rayne and Kaptijn. The remains of canals and channels are often visible on the imagery, and mapping such systems can lead directly to quite complex questions of political economy and social organisation.

Technology

The declining costs of imagery and the automation of processes necessary to utilise it, as well as the emergence of open access software such as Google Earth, are now having a further transformative effect. We saw in this volume that multiple data sources, including CORONA, multispectral, DEM, and high-resolution imagery are consistently used to assess a variety of landscape archaeological problems. Such data sources are often used together to best leverage each platform's advantages, while also integrating information with archaeological or geoarchaeological approaches such as survey and sediment analysis. In this volume, the papers by Stone, Hritz and Pournelle, Jotheri and Allen, Rey and LeCompte, and Sauer *et al.* all demonstrate the efficacy of such an approach and the interpretive power available through integrated mapping from sources within our current satellite array. Cunliffe and de Gruchy's paper takes this one step further, using an increasingly common method of comparing 1960s CORONA photography with modern imagery to assess damage to features in the landscape of the North Jazira (see below). It is clear that we need to continue to take advantage of new technologies as they become available in this rapidly developing discipline. Advances in Digital Elevation Models through techniques such as RADAR, LiDAR and CORONA photogrammetry, for example, will enable us to 'see' more of the landscape and extract archaeologically relevant information, whilst at a smaller scale the burgeoning use of drones also holds much promise.

Technological advances in sensors and platforms can be supplemented by advances in analytical techniques. Automated multi-source data fusion, where algorithms and techniques are allowing a more sophisticated statistical approach to data representation, are of interest here. Such fusion incorporates ground-, aerial-, and satellite-based systems, whereby elevation, multispectral, and photographic data are used together to identify features of relevance (Zhang 2015). With the availability and utilisation of high performance computing (HPC; Zare *et al.* 2014) in data fusion, we expect such approaches to become increasingly available to archaeologists. Automation has its critics, with some arguing for a greater use of 'brute force methods' (Casana 2014), meaning manual classification by trained image interpreters (one might read 'graduate students' here!). It is undoubtedly true that the current capabilities of computational site identification, whilst impressive (see, for example, Menze and Ur 2012), cannot replicate the interpretive capacities of genuine human expertise in understanding complex or ephemeral sites and features.

A further issue with the manual approach is the large amount of labour involved. This highlights the importance of understanding the likely costs and benefits of different methods, an area where our understanding remains underdeveloped. Given the need for substantial computational and digital storage capacity, access to software (and types of data) which involves a steep learning curve, some mathematical understanding on the part of the users, and support for data security, management and archiving, it becomes apparent that these techniques pose problems in terms of staff training and sustainable funding, quite different from those that have traditionally applied to field-based research. It is for this reason that, as with advanced biological archaeology, work undertaken in this area has occurred within large, well-funded projects, based in institutions that can attract and support post-graduates and research assistants required to perform the tasks of image processing, rectification, analysis, and other required techniques. While this situation is unlikely to change any time soon, an alternative model is provided by crowdsourcing platforms (Estellés-Arolas and González-Ladrón-de-Guevara 2012) which are increasingly being utilised in archaeology and offer both a new source of labour and new ways of engaging with the public. In either case, a key concern must be the quality of the data produced, and the variability introduced by multiple subjective interpretations.

On the fieldwork side, there is a lot Near East archaeology can learn from work done in other regions and even other disciplines, including Geography and Earth Sciences. Much of Tony's work involved extending ideas from other disciplines into archaeology to make better archaeological inferences. At a subsurface level, we are beginning to see the study of microfossils applied to wider areas in the Near East to understanding the past environment and its relationship to human societies (Rosen 2007). Cave systems, and speleothems in particular, are plentiful in the karstic landscapes of the Near East and have been proven (Bar-Matthews *et al.* 1997; Fleitmann *et al.* 2009) to be some of the best repositories of palaeoclimate data available to us. As new work is now spreading to some of these karstic regions, one expectation is a better exploitation of these data to resolve long-standing climatic and chronological debates and how they affect key events in the Near East, including the emergence of agriculture, early urbanism, and the rise and fall of empires.

Beyond mapping: scale

A major challenge in archaeology at a general level is how to deal with issues of scale, in terms of increased geographical space and temporal breadth, but also how we conceptualise social relations. Part of this problem comes from the nature of the material record itself, as the limitations of data often mean we can only hope to obtain snapshots of society or a general period overview. Despite this, assumptions are still made across social scales, linking decisions made at a local level to enduring institutions and broader patterns. In part, there are technical approaches that can address these considerations, including complexity modelling, GIS, spatial analysis, agent-based modelling and other analytical methods (Lock and Molyneaux 2006), but data limitations remain the primary hindrance in best utilising the techniques mentioned. High precision dating techniques and Bayesian modelling help to address some of the time-dependent issues by providing greater chronological precision (Ramsey 2009), but the high costs involved mean such dating is rarely applied at large volumes of samples, let alone across multiple sites and regions.

The growing availability of imagery, in combination with advances in computational power and storage, has led to a step-change in the scale of analysis being undertaken, exemplified in this volume in the papers by Casana, Lawrence and Rey, Iamoni, Smith, and Bradbury and Philip. Here, satellite imagery is being used to examine trends in the settlement of the living, and the disposal of the dead over very large regions, crossing national boundaries and traditional scholarly divisions such as that between northern Mesopotamia and the Levant. The production of such large datasets requires scholars to consider the quality and comparability of the underlying data, and to think about ways of capturing variations in recording techniques, chronological sequences and field methods (Alcock and Cherry 2004: 4). Finding ways to organise, display and interpret data at this expanded scale without becoming reductive is a further challenge. Chronological sensitivity is perhaps the most pressing of these challenges, and the time block approach developed for the Fragile Crescent Project in Durham to work around the issue of conflicting local periodisation schemes (Lawrence *et al.* 2012; Wilkinson *et al.* 2014) and used here by Bradbury and Philip, along with morphological interpretations used by Lawrence and Rey, and Casana, represent novel approaches in this area.

More generally, new theoretical concepts are required to articulate the relationships between individuals and societies, and to examine the material culture and landscape signatures visible in the archaeological record in this light (see papers in Robb and Pauketat 2012). The very broad scales at which landscape archaeology is now able to operate, particularly through the use of remote sensing approaches, can provide information on trends which are unrecognisable through other means. Recent work by the Fragile Crescent Project, for example, has demonstrated the presence of a range of trajectories of settlement in advance of the so-called 'second urban revolution' in Northern Mesopotamia and the Levant (Wilkinson *et al.* 2014; Lawrence and Wilkinson 2015). Certain kinds of social phenomena, such as empires, can have an impact over vast areas, and it is only by examining and combining data from multiple local sources that these effects can be discerned. We see the possibility of investigating empires at a scale which is consistent with, or even greater than, their actual physical footprint as an exciting new area of study.

Future developments: heritage

Whilst fieldwork across the Middle East may be curtailed by political events which render certain countries or regions inaccessible to archaeologists, particularly from the West, remote sensing can play a vital role in continuing research. Even more importantly, the ability of satellites to revisit specified locations on a regular basis provides an effective means of monitoring change — in particular site-damage through looting, deliberate destruction or opportunist activity such as uncontrolled development. It seems increasingly likely that when linked to appropriate database software, the large settlement datasets, created by research projects will make an important contribution to the creation of regional or national historic environment records, of a kind that will be vital for heritage organisations in the Near East and wider region. Steps in this direction are already being taken by projects such as the American Schools of Oriental Research Cultural Heritage Initiatives (http://www.asor-syrianheritage.org/) and Endangered Archaeology in the Middle East and North Africa (http://eamena.arch.ox.ac.uk/).

However, the growing dependence on large repositories of digital information highlights the need for capacity building within these bodies, and the development of retention strategies that recognise the attractiveness of personnel with good IT skills to a wide range of alternative employers. In terms of technical matters, the cost and licensing issues that attach to much commercial software mean that there may be an important role for free-to-use open source products. Furthermore, many of the issues of data quality, security and organisational sustainability that arise in the case of Western research institutions are likely to be even more acute in under-resourced regional antiquities offices; the potentially profound impact that the growth of non-Western modes of heritage governance (Winter 2014) might have upon the situation remains another imponderable.

Conclusion

As discussed in Gibson's introductory chapter, remote sensing has a long history in Near Eastern archaeology. A combination of factors, including the prevailing land cover and climate types, long term forms of settlement leaving marked archaeological traces and the recent geopolitical importance of the region, have led to a unique situation for archaeologists. There is arguably nowhere else in the world where such a large proportion of the material record is detectable from space and at the same time remote sensing sources through time are so plentiful. The importance of the region as an arena for the 'pristine' development of agriculture, social complexity, urbanism, and empires coupled with the current political conditions preventing or severely curtailing fieldwork in certain areas only adds to the importance of the remote sensing record. Historically, Near Eastern archaeologists have been relatively quick to adopt new technologies, at least in comparison with those working in many other areas of the world. Where we have been less successful is in integrating our results into broader theoretical and interpretive frameworks, and it is here that we see significant room for improvement.

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New Agendas in Remote Sensing and Landscape Archaeology in the Near East is a collection of papers produced in honour of Tony James Wilkinson, who was Professor of Archaeology at Durham University from 2006 until his death in 2014. Though commemorative in concept, the volume is an assemblage of new research representing emerging agendas and innovative methods in remote sensing. The intention is to explore the opportunities and challenges faced by researchers in the field today, and the tools, techniques, and theoretical approaches available to resolve them within the framework of landscape archaeology. The papers build on the traditional strengths of landscape archaeology, such as geoarchaeology and settlement pattern analysis, as well as integrating data sources to address major research questions, such as the ancient economy, urbanism, water management and the treatment of the dead. The authors demonstrate the importance of an interdisciplinary approach for understanding the impact of human activity on shaping the landscape and the effect that landscape has on sociocultural development.

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