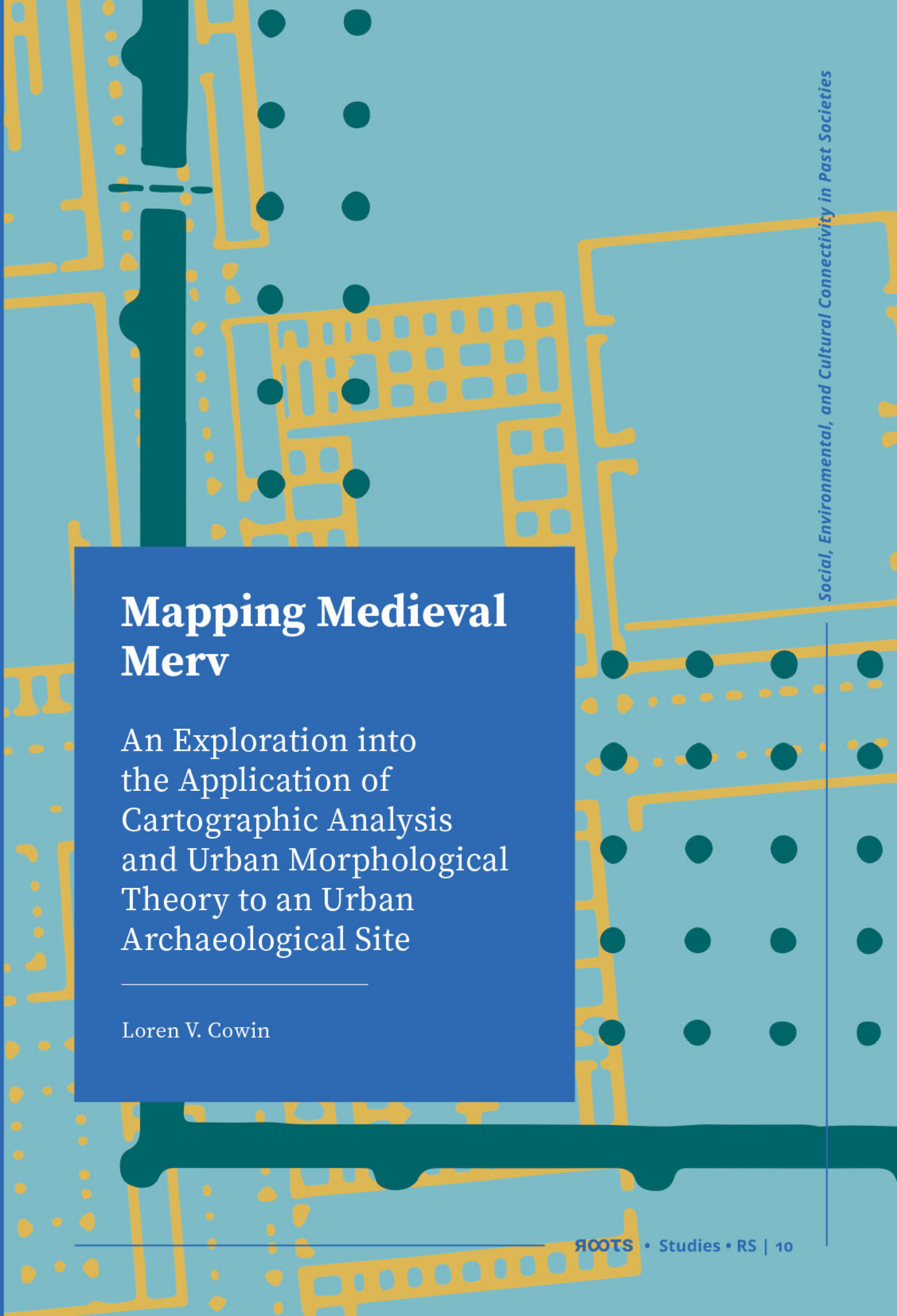

Mapping Medieval Merv

An Exploration into the Application of Cartographic Analysis and Urban Morphological Theory to an Urban Archaeological Site

Loren V. Cowin

Social, Environmental, and Cultural Connectivity in Past Societies

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Foreword of the series editors

As the outcome of overarching, interdisciplinary scientific research efforts within the Excellence Cluster 'ROOTS – Social, Environmental and Cultural Connectivity in Past Societies' at Kiel University, we are pleased to present the tenth volume of the publication series **ROOTS Studies.** This book series of the Cluster of Excellence ROOTS addresses social, environmental and cultural phenomena as well as processes of past human development in light of the key concept of 'connectivity' and presents scientific research proceeding from the implementation of individual and cross-disciplinary projects. The results of specific research topics and themes across various formats, including monographs, edited volumes/proceedings and data collections, are the backbone of this book series. The published volumes serve as a mirror of the coordinated concern of ROOTS researchers and their partners, who explore the human-environmental relationship over a plurality of spatial and temporal scales within divergent scientific disciplines. The associated research challenges revolve around the premise that humans and environments have interwoven roots, which reciprocally influence each other, stemming from and yielding connectivities that can be identified and juxtaposed against current social issues and crises. The highly dynamic research agenda of the ROOTS Cluster, its diverse subclusters and state of the art research set the stage for particularly fascinating results.

Lauren Cowin's doctoral dissertation, showcased in this volume, presents a GIS-based study on the urban morphology of the built landscape of Merv, Khorasan, Turkmenistan, mapping the medieval Islamic city space of Sultan Kala. Cowin

makes use of archaeological survey data, which enables us to make important features of the complex topography visible with differing resolution according to diverse preservation conditions. In this context, the author is able to demonstrate how the development of medieval Merv represents a significant transformation of the urban concept, mirroring larger regional developments in Central Asia. Loren's findings can be used as a guide for future fieldwork and further research on urbanisation in the region. The urban DNA can be read beyond the heuristic or exploratory character of an urban morphological analysis. The insights gained in this way can serve as a starting point for further work, which can range from prospective methods to excavations.

The editors of the **ROOTS Studies** series would like to take the opportunity to thank those colleagues involved in the successful realisation of the tenth volume. We are very grateful for the detailed and well-directed work of the ROOTS publication team. Specifically, we thank Andrea Ricci for his steady support and coordination efforts during the publication process, Petra Horstmann for image editing and the preparation of the cover design and Eileen Küçükkaraca for scientific editing. Moreover, we are indebted to our partners at Sidestone Press, Karsten Wentink, Corné van Woerdekom and Eric van den Bandt, for their support and their commitment to this publication.

Kiel, March 2025
Eileen Eckmeier, Martin Furholt, Lutz Käppel, Johannes Müller

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Preface of the author

As many, if not most, graduate students do when first approaching their work, I had enthusiastic ideas and goals when I envisioned this project for my master's thesis. I was provided with highly detailed drone imagery of a vast medieval city, and due to my abiding interest in cartography, I set out to compose a map of the site. But composing a map could not provide a robust enough topic for a thesis – Master's, doctoral, or otherwise – or, so I thought. As I saw it, a map must be used for something, thus I intended to demonstrate its usefulness by identifying neighbourhoods, quarters, and the like, in order to show the past social organisation of the city. By the end of my work on the thesis, I realised that there are plenty of methodological and epistemological questions about making a map of a complex archaeological site suitable for a doctoral thesis. Indeed, several of the topics covered in this work could themselves be topics for theses, and so what is presented here is admittedly broad in scope.

Despite the high quality of the data I was able to work with, I planned several seasons of field work to gather data to shore up my methodology and mapping process. But, no field work was carried out. Along with the setbacks that everyone experienced when the novel Coronavirus halted everything in 2020, excavations in Turkmenistan were set back when the president of Turkmenistan went missing during a field season planned the year before, effectively halting all government bureaucratic processes, including applications for visas into that sequestered country. Ultimately, what I had to work with was highly detailed aerial imagery,

some archaeological reports, and a very few questionable historical accounts. However, I was seldom sure of what I was looking at in the data.

The process of mapping the remains of this city with the data available to me was similar to what I imagine it would be like to replicate an incomplete jigsaw puzzle from a distance with the aid of a telescope and only a vague notion of what image it might depict. What the reader should understand from my circuitous exposition is that this thesis is as much an exercise in testing the limits of the methodology of remote sensing and mapping in archaeology as it is about Early Islamic urbanism. The resultant map[1] and the knowledge that can be gleaned from it is general, subjective/interpretive, and incomplete. In fact, as the reader may notice, I am reticent to even use the word 'conclude' when referring to the Merv that the map produced, as its use in the manner it is often used in academia seems to confer a stronger sense of confidence than I find merited in this case.

Yet as the reader will also come to understand, the products of the research for this thesis are nevertheless useful. I hope, then, that this thesis will be valuable in expanding upon the topics that it touches upon. At the very least, as a lesson in humility and the process of research, it was a valuable experience for me.

This thesis would not have been possible without the support and guidance of my supervisors, Prof. Dr. Ulrich Müller and Prof. Dr. Bethany J. Walker. I would like to thank Ulrich for accepting me as his student and his unbroken positivity, and I would like to thank Prof. Walker for offering new perspectives and avenues of research. I would like to thank them both for their support and patience. I am also deeply grateful to my Master's adviser Tim Williams and Dr. Gai Jorayev of University College London who provided me with the data to make this thesis possible. I am thankful to the friends I made in the ROOTS Excellence Cluster at Kiel and at the Institute of Islamic Archaeology, Bonn who helped make my time as a PhD student a memorable and enjoyable experience.

I am very grateful to my family, especially my best friend, Isabelle, for pulling me away from my computer screen to go outside. Finally, this monograph is dedicated to my bright and brilliant late spouse, Edoardo Yves Canonica, who never hesitated to help and support me.

The reader will find it useful to consult the online GIS project for this thesis, which can be found at: https://qgiscloud.com/LCowin/MedievalMerv/. Unfortunately, the GIS package through this URL does not contain the metadata, but this will be freely provided by contacting the author at Loren.V.Cowin@gmail.com or it can be accessed from the OpenData Portal of Kiel University under: https://doi.org/10.57892/100-322.

Loren V. Cowin
Spring 2025

1 Many maps in this publication were created using data from Microsoft Bing Maps © [2023]. Map data and imagery © Microsoft and its data suppliers.

Chapter 1: Introduction

Situated within the Karakum desert in the present state of Turkmenistan is the Merv Oasis, itself a part of the fertile inland Murghab River Delta. The relative habitability of the oasis has made this an attractive place of settlement and refuge from the surrounding desert for a considerable length of time, as evidenced by the presence of both modern agricultural settlements and the many archaeological sites. For these reasons, the oasis had been a major stopover along the ancient and medieval Silk Roads.

The archaeological sites of Merv, or variously Merw, date from antiquity to the early modern eras, and vary in size from single structures to, most pertinently, entire cities. Depending on how one counts separate sites, the number of archaeological cities in the oasis ranges from three to four and they extend in date from the 5th century BCE to the 15th century CE (Fig. 1). The city that developed during the early medieval and classical Islamic periods, Sultan Kala, is the largest of the city sites. At various times, from 748 CE/130 AH-1221 CE/617 AH, Merv was of the most significant centres of the Islamic world known for its numerous libraries and was, on occasion, the capital of Islamic empires, in particular around the Seljuk period (1037 CE/428 AH-1194 CE/590 AH).

Merv was perceived as so splendorous that it was known as Marw al-Shahijan, roughly translated as 'kingly Merv' (Herrmann 1999).

The current site of Sultan Kala covers a vast intramural area of six-hundred hectares, a significant size for an urban archaeological site and pre-industrial city. In spite of some agricultural developments in the area, the site has been largely

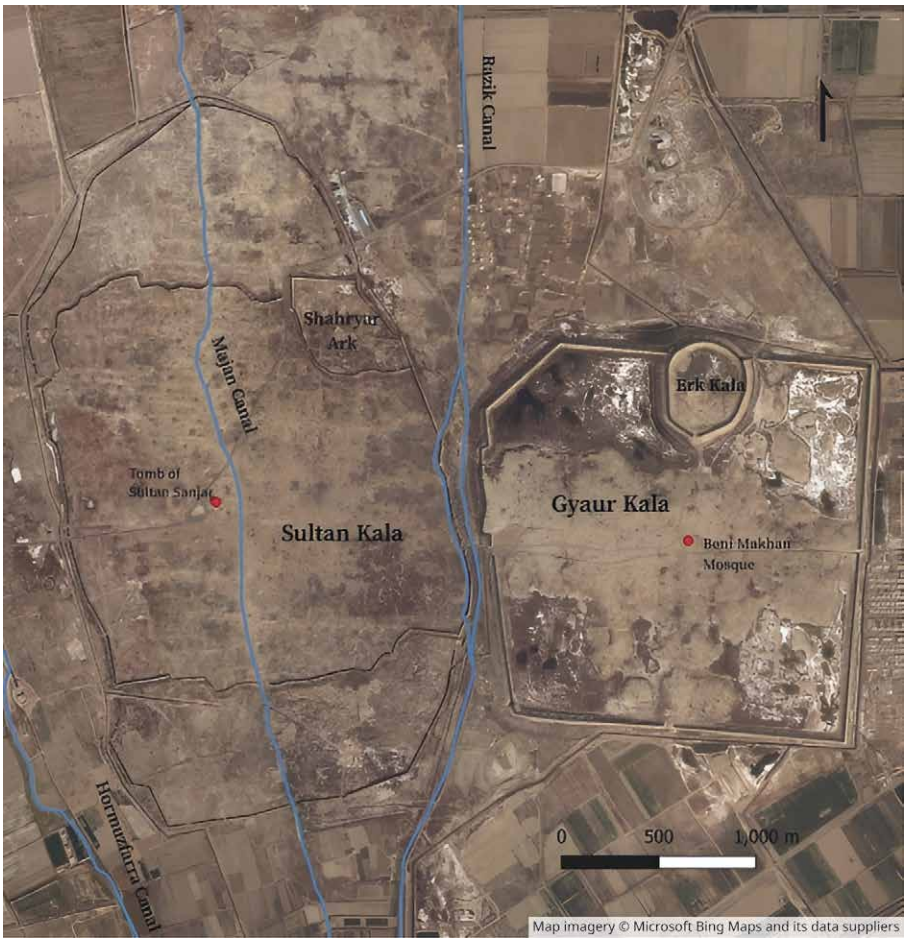

Figure 1. The ancient and early medieval city sites of Merv (Source: image created by the author; Bayramaly, Türkmenistan. Map imagery © Microsoft Bing Maps and its data suppliers).

unmolested by urban developments since it was sacked by the Mongols in 1221 CE, as it was effectively abandoned thereafter. This means that, with varying degrees of preservation, much of the remains of architectural features are visible on the surface, creating a landscape with a distinctive urban archaeological topography. The site was almost entirely constructed using earthen architecture, which does not withstand the erosive properties of the environmental elements easily, and yet there are some monumental structures that are currently partially standing.

The erosion of the site has accelerated since the 1990s due to the intensification of agricultural activities in the area. Many of the partially standing monuments exhibit 'undercutting' at their foundations and have further collapsed. Yet, much of the sub-surface collapsed architecture and urban features have left a relief in the landscape, making the remains at least partially discernible. In order to document the visible surface archaeology of the site thoroughly in response to its continual degradation, Merv was extensively photogrammetrically surveyed in the 2010s by the Ancient Merv Project of University College London using an unmanned aerial vehicle (UAV).

Together with open-source satellite imagery, the UAV data enables examinations of the archaeological topography of medieval Merv. This can readily be performed by geographical information systems (GIS) that provide the means to manipulate and enhance the said photographic data. The intuitive product from this examination is a map or a series of maps. Accordingly, this thesis relies heavily on the data collected from the aforementioned project as a base to explore the

utility of using this kind of data cartographically to better understand the spatial, developmental, and socio-cultural aspects of medieval Merv, and more specifically Sultan Kala. As much as the detailed and data-rich imagery are a boon to map the site, the process is not without its challenges, especially in the case of a sizable archaeological site that is mostly unexcavated and unexposed, such as Merv. What elements of a city and features of an archaeological urban site should be depicted and mapped? And more fundamentally, how accurately can the archaeological features in the landscape be transcribed and interpreted? How can knowledge from other sources, such as excavations and historiographic accounts, aid in the mapping process and to what degree?

However much theoretical and interpretive thought is required in the process of mapping a site, it would be remiss to cease inquiry with the resultant product, for maps can express more than visual spatial relationships. What can the map(s) reveal about the socio-spatial relationships and historical development of a city, and more specifically of an urban archaeological site such as Merv?

To aid an examination of these topics, a number of models, methods, and theories from different fields are consulted. The field of urban morphology, or urban form, is heavily relied on in this thesis, although it is a broad field and so only several pertinent approaches and theoretical lenses are outlined, and yet fewer are applied here. Overall, urban morphological theories and approaches have not been employed to any significant extent within archaeology – the methodological body of space syntax can be considered an exception although there is no lack of historical focused research within urban morphology. Yet, as its theory and methodology are empirically derived, and much of the spatial principles are already familiar to archaeology, urban morphology may have practical contributions in archaeological applications (Smith 2011). As will be further elaborated on below, theoretical perspectives associated with urban morphology provide much of the base for an understanding of the spatial properties and fundamental elements of cities and built environments in general. Some elements from methodological approaches employed within the field are also used to understand how and which urban elements should be transcribed in the mapping process. Finally, a combination of theory and method from urban morphology can also provide a means of interpreting the development and spatial relations of a cityscape, which in this case is Sultan Kala. As previously stated, however, many of the practical urban morphological approaches have not been strictly applied in archaeological contexts, and so their utility for studying urban sites is not fully appreciated. How effective will the application of urban morphology to a site such as Merv be at gleaning productive conclusions and providing substance for further research?

The body of knowledge from urban morphology mostly aids in understanding the characteristics of urbanism in general. However, as is particularly the case with premodern cities, the spatial properties, architecture, and development of medieval Merv were likely heavily influenced by its culturally regional and historical contexts. To better understand the form of Sultan Kala and how to better map it, these particulars must also be appreciated. Having been peacefully conquered and incorporated into the Islamic world in the 7th century CE, medieval Merv is situated into an Early Islamic cultural and historical context. As Sultan Kala developed exclusively in these conditions, it has indeed been referred to as an "Islamic city" (Williams 2008). There is a substantial body of scholarly research on the morphology and history of 'Islamic cities' which was sourced heavily in this thesis in order to better conjecture the spatial properties and elements that Sultan Kala possessed.

The concept of the 'Islamic city' has received a due amount of scholarly scrutiny, however, and is still a robust subject of scholarly exploration, particularly in the areas of the historical and regional expressions of Islamic urbanism. This thesis then briefly outlines the scholarship of these areas as well. How does medieval Merv relate to 'Islamic urbanism', its regional and historical expressions, and can it help to elaborate the subject?

The topics summarised above are examined here, aiming to:

1. produce a series of GIS overlay layers that will function as maps of medieval Merv for different purposes. The purpose of some layers will be to depict observable features of the archaeological topography, while others will be aimed at depicting the interpreted and hypothesised developmental and spatial properties of the city;
2. apply methods and theory from urban morphology and the study of Islamic urbanism in order to map, analyse, and interpret the topography of Sultan Kala and its development;
3. assess the utility, advantages, and limitations of both mapping a site using photogrammetric data and applying urban morphological theory and methods to archaeological sites;
4. evince some novel knowledge concerning the past socio-spatial form of medieval Merv, its historical and spatial development, and how it relates to Islamic urbanism.

Chapter 2: Geographic and historical contexts

2.1 Cultural and historical geography

This section will outline the regional context of Merv. What is meant here as the pertinent regional context is loosely denoted as modern designated western Central Asia. While modern definitions of Central Asia differ, for the purposes of this thesis the western part corresponds to the modern states of Turkmenistan, Uzbekistan, Southwest Kazakhstan, Northwest Afghanistan, and Northeastern Iran. This geographical region was composed of many different geographical and administrative regions in pre-modern times, but shared enough cultural similarities and historical trajectories to be considered an analytical whole in which Merv is situated. However, the intended meaning does not imply that this region was culturally homogeneous throughout its geographical expanse and history. Indeed, there were many co-existent cultural groups – Arab, Persian, and Turkic as the most prominent – so it could also be defined as a "geographical region of significant mutual cultural influence". In contrast to other regions that experienced Arab invasions, Central Asia went through a much more gradual process of conversion and acculturation (Sobti 2005), thus setting it apart as region of study. Moreover, this region is fairly similar to the *iqlim* (geographic region) of al-Mashriq, according to al-Muqaddasi writing in the 10th century CE, which thus lends support to use this region as a geographical and cultural unit of study (Wheatley 2001).

The two principal historical regions of western Central Asia/Al-Mashriq used here are Transoxiana and Greater Khorasan (Fig. 2). The former is the Roman/Latin designation for the area between the Oxus/Amu Darya and Jaxartes/Syr Darya rivers,

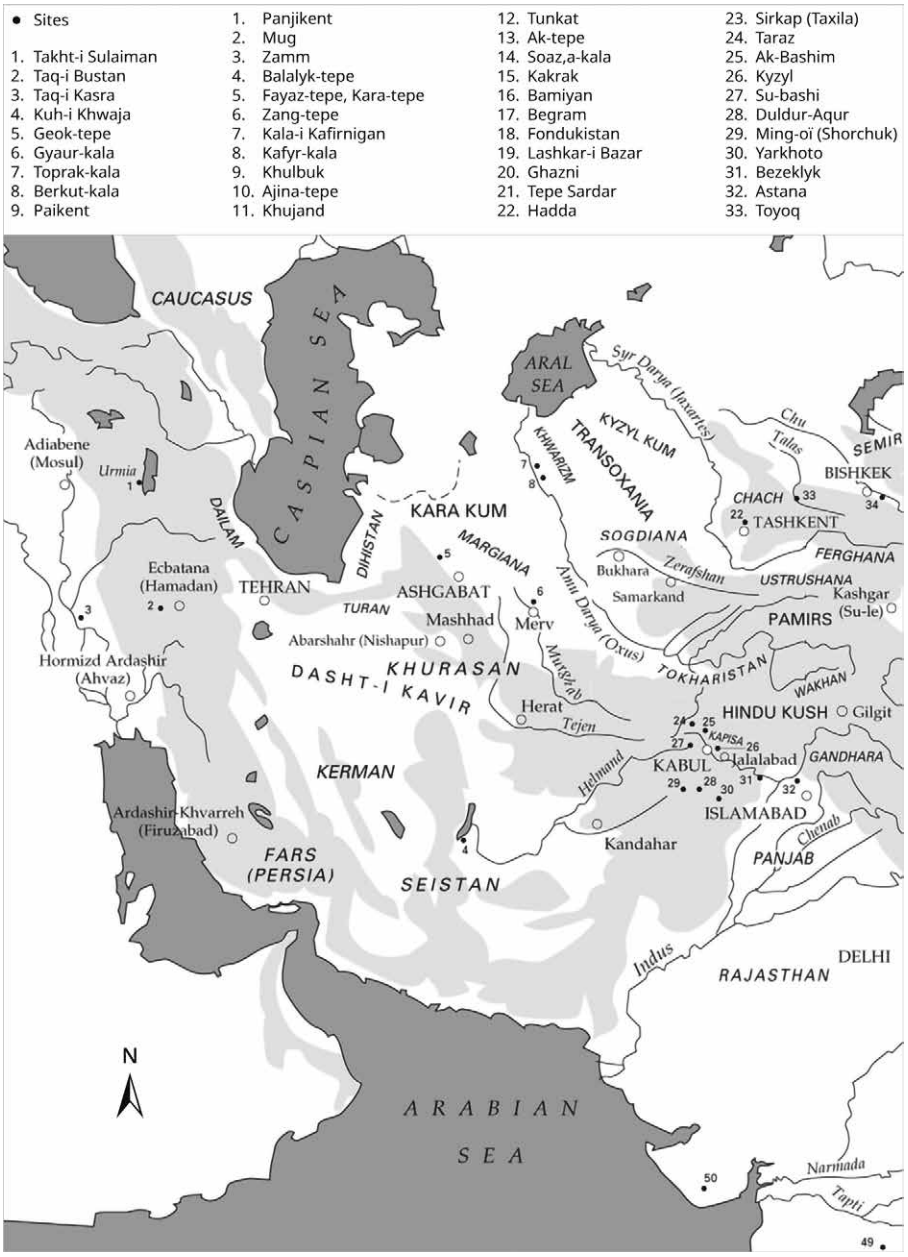

Figure 2. Map of Central Asia from the 4th to the 8th centuries CE (after Dani *et al.* 1996, 488; https://unesdoc.unesco.org/ark:/48223/pf0000104612).

and was later called *Mawarannahr* after the Arab conquest.[2] Greater Khorasan is a more difficult region to define as the term's usage varied between periods and authors. Adjacent regions which would have been under the political or cultural influence of Khorasan, such as Transoxiana and Khorezm, were sometimes included in the usage of the term (Rante 2015).[3] Suffice it to say that for centuries from antiquity into the medieval era, Khorasan and much of western Central Asia were either within a Persian cultural sphere or heavily influenced by Persian culture.

2 Both terms, Transoxiana and Mawarannahr, are similar in meaning and translate to "(land) beyond the (Oxus) River". Before the late antique and early medieval periods, the region was referred to as Sogdia/Sogdiana. While all terms are used to varying degrees in scholarly writing depending on the cultural/historical context, Transoxiana seems to be the predominant term for the area even in the medieval Islamic period.

3 The ambiguity and difference in terms extends even to modern scholars, with Pourshariati (1998) taking issue with the designation of "Khorasan Proper" in favour of "Inner Khurasan" and "Outer Khurasan" (in which she places Merv).

2.2 Site and regional history

2.2.1 Merv

Here, the history of Merv will be briefly summarised with a focus on significant events in the medieval period.[4]

The earliest evidence of the site now known as Merv is found in Margiana during the Achaemenid period (6th-4th centuries BCE), when it is mentioned as a settlement of some importance (Adle *et al.* 2003). The current site of *Erk Kala* corresponds to this period (Fig. 1). The size of the site suggests that it likely functioned as a fortified urban outpost for the Achaemenid empire rather than as what would normally be considered a city, although this is the initial 'kernel' from which further urban development and a successive site grew.

The following historical periods – the Hellenistic and Persian – can be combined in terms of urban development and morphology since the urban expansion would be the primary site of occupation until the coming of Islam. Although some urban agglomeration around Erk Kala had likely already developed, the city was officially expanded under Antiochus I Soter (3rd century BCE) in which it can be seen in the present site of *Gyaur Kala*, and of which *Erk Kala* would become its citadel (Fig. 1).

The Arab conquest of Mawarannahr began in the late 7th CE/1st AH centuries and continued into the early 8th CE/1st-2nd AH centuries due to regional rebellions and the need to 'reconquer'. Merv came under Umayyad rule in 650-651 CE/29 AH by *sulhan* – meaning peacefully through treaty – instead of by force. In the 660s CE/40s AH, Merv came under official governorship with 'Ubaidalla b. Ziyad as governor. During the early 8th CE/1st -2nd AH centuries, Merv served as a garrison and base for further conquest raids into neighbouring Transoxiana (Baumer 2016). The Umayyad Caliphate was primarily concerned with establishing and enforcing a centralised administration, settling Arabs, and at times, repressing rebellions.

The caliphate was not particularly interested in influencing culture (Anisi 2008). Additionally, the Umayyads generally eschewed the establishment of new urban settlements – except in a few exceptions when deemed necessary – despite the settlers' common desire for city life. The favoured pattern instead was to have settlers housed in already existing cities (Dani *et al.* 1996). This pattern of the Umayyad administration would have some effect on the urban structure. Through the Arab settlers' desire for city life, the inhabitants of Merv were required to house 4,000 Arab soldiers (Wheatley 2001), and many of the *dihqans* (Sassanian/Persian land-owning nobles) deserted the city for a more rural or suburban life. Additionally, it can reasonably be asserted that the first mosque was built during this time, likely where a much later ruined mosque still stands at the crossroads of the two main streets in the centre of the walled city (Williams 2018b) (Fig. 1).

As mentioned, the Umayyad administration had to often deal with rebellions and unrest in Mawarannahr. The dissatisfaction with Umayyad rule stemmed from their preference for elites and over taxation; more specifically, for not exempting converts from the *'jizya* (non-Muslim tax). Starting in the markets of the Madjan

4 Kennedy (1999) provides an excellent outline of the history of medieval era Merv, which the reader should study for a more thorough exposition on the subject. For a comprehensive history of the region during the medieval era, the reader should look to Peacock and Tor (2015) or for a somewhat less academic – although excellent and accessible – thorough history, see Starr (2013). Finally, see Bartold (1928) which is often cited as the earliest extensive monograph on the subject.

suburb Merv, the successful Abbasid revolution lead by Abu Muslim finally ended Umayyad rule in Merv in 747 CE/129 AH, and after spreading further afield, would end and replace the Umayyad Caliphate with the Abbasid. Abu Muslim became the governor of Khurasan until his assassination in 755 CE/137 AH and is accredited with establishing the *Dar al-Imara* and new congregational mosque in the Madjan suburb as well as moving the markets there (Herrmann 1999).

Although it was a springboard for the new caliphate, Merv would remain a provincial capital for nearly the rest of the Abbasid regime in Khurasan. This would change in 811 CE/195 AH, when Al-Ma'mun, the governor of Khurasan residing in Merv, proclaimed himself caliph after defeating the army of his brother, Caliph Al-Amin. For a brief period of seven years, Merv was the capital of the caliphate. Likely due to Merv's peripheral location within the empire, Al-Ma'mun left Merv in 818 CE/202 AH and appointed governors for the provinces shortly thereafter. In 821 CE/204 AH, Al-Ma'mun appointed Tahir b. al-Husayn – formerly his general who had defeated Al-Amin's army – governor over Khurasan in Merv, thereby officially demoting Merv to a provincial capital.[5] However, Tahir distanced himself from the caliph and began an eponymous lineage of 'governors', who were essentially independent from the caliphate. From 821CE/204 AH, Merv served as the Tahirid capital – until 830 CE/215 AH, when the capital was moved to Nishapur. Merv would not have the privilege of being the centre of governance for another 225 years (Dani *et al.* 1996; Kennedy 1999).

Tahirid rule in Khurasan ended in 873 CE/259 AH (in 880 CE/266 AH in Merv), when the Saffarids displaced them. A brief and turbulent interim followed, until the Saminids came to power in Mawarannahr and Khurasan in 900 CE/287 AH. This was followed by Ghaznevid rule in the region from 999 CE/389 AH to 1037 CE/428 AH. During this period of 200 years, Persian art and culture prospered – the Samanids were themselves *dihqans*, noble land owners – and hence this period is known as the Iranian Intermezzo (Dani *et al.* 1996). It can be reasonably assumed that Merv remained a significant city and enjoyed some of this prosperity, yet it is barely mentioned in the historiography, with a few exceptions, which will be explored below (Kennedy 1999).

The rule of the Seljuks was next most significant period to follow for Merv and the region. Around the turn of the 10th century, when the rule of the Ghaznevids was precarious, the Oghuz Turks of Khwarazmia and neighbouring regions, led by Seljuk Beg, were expelled from that land. After converting to Islam, they crossed the Amu Darya and seeing the unsteady rule of the Ghaznevids, they defeated them in battle and peacefully took control of Merv in 1037 CE/428 AH. Nishapur and Isfahan would shortly follow and by 1055 CE/446 AH the Seljuks reached Baghdad, where they solidified their influence in the Muslim world when the Abbasid Caliph deemed Tughril Beg as sultan. From this time on for the next 100 years, Merv had the title *Dar al-Mulk*, or capital. However, little changed administratively until the rule of Sanjar, and the city effectively remained a provincial capital while also serving as a headquarters for military campaigns into neighbouring Khwarazm.

In 1095 CE/488 AH, many of the towns and cities of Khurasan, including Merv, were subjected to attacks and significant destruction. These attacks were carried out by the aspiring *malik*, Arslan-Arghun – a brother of Sultan Barkyaruk – as a consequence from an attempt to oust him, but his rationale for doing so is not clear.

5 The previous dates given may differ slightly between sources, depending on the interpretation and preference of official and unofficial dates of a given reign of a ruler.

This unfortunately resulted in the destruction of Merv's walls and gates, and many of the inhabitants were killed.

These events led to the arrival of one of the most significant figures in Merv's history, Ahmad Sanjar. As a brother of Sultan Barkyaruk, Sanjar was sent to Khurasan in 1097 CE/490 AH to put an end to Arslan-Arghun's rampage and re-establish order. However, Arghun was assassinated by one of his own soldiers as Sanjar was en route, and as he and Barkyaruk arrived in Khurasan, Sanjar peacefully took command of the army. Sanjar and Barkyaruk entered Merv, where Sanjar would remain for about sixty years until his death in 1157 CE/552 AH (Kennedy 1999).

Initially, Sanjar was appointed as the lesser sultan of the Seljuk state in 1097 CE/490 AH, but effectively ruled a separate state from Merv in the eastern part of the empire. Sanjar came to hold the title of Great Sultan in 1118 CE/511 AH, but only after he wrested it from his nephew, to whom the title had passed after the death of Sanjar's brother, Mohammad Tapa (Tor 2009). Merv served as the capital of the Seljuk Empire, and most of the Islamic world, for nearly the rest of Sanjar's life.

During his reign, Sanjar was occasionally away commanding military campaigns, as there was some strife with incurring nomadic tribes and minor rebellions. Despite Sanjar's success as a military leader, warring tribes and rebellions verify that Seljuk control of Greater Khurasan and Transoxiana was deteriorating. This situation eventually reached Merv in 1141 CE/536 AH, when the approaching nomadic Karakhitai from the north of Khurasan defeated the Seljuk army after a dispute with Sanjar and sacked Merv. Worse yet, in 1153 CE/546 AH during a battle that arose from a dispute with local leaders, Sanjar was captured by the incurring nomadic Turkmen Ghuzz tribe and Merv was sacked repeatedly. Sanjar spent three years in relatively comfortable captivity until he was allowed to return to Merv 1157 CE/549 AH, shortly before his death (Starr 2013). Although Merv barely appears in historiographic accounts during his reign, as the centre of political power, it was undoubtedly a prosperous time for the city. That Sanjar was so significant for Merv – and indeed much of the Islamic world – is evidenced by his great domed monumental mausoleum, which influenced many subsequent domes in Islamic lands, and yet stands at the centre of Sultan Kala (Hillenbrand 2012).

The defeats and death of Sultan Sanjar coincided with the fracturing of the Seljuk Empire. Khurasan, which had been the centre of the Seljuk Empire and much of the Islamic world, also began to rapidly lose its primacy, although it had already been somewhat in decline decades before this. Whether Sultan Sanjar's death was a direct causal factor for this or not,[6] it undoubtedly was a significant influential element.

With the death of Sultan Sanjar and the ensuing dissolution of the Seljuk Empire, Merv naturally lost its status as a capital. The subsequent few decades were politically unstable for the city and the region, as Merv was fought over and passed from various factions such as the Ghuzz, Khwarazmshah, and the Ghurids. In the beginning of the 13th century, Merv would even lose its title as a provincial capital to Nishapur. It is unclear, however, to what extent the change in political status negatively affected Merv's prosperity and development, if at all. The scholar Yaqut wrote very favourably of Merv, having lived there for three years shortly before the Mongol attack. He particularly noted the good nature of the inhabitants and the

6 This has recently been a subject of scholarly contention of apposing ideas. Bulliet (2009) argues that the decline of Khurasan was largely due to climate and ecology, Tor (2018) considers it overwhelmingly due to human agency.

many libraries, and professes that he would have stayed there for the rest of his life were it not for the destruction caused by the Mongols[7] (Herrmann 1999).

Having conquered Bactria and the surrounding regions in 1220 CE/617 AH, the Mongols arrived at Merv in early 1221 CE/618 AH. It seems as though there were differing ideas within the city about how to respond to the Mongols, which has led to a somewhat confusing account of the conquest. The governor at the time, Mujir al-Din, was expected to resist the Mongols, while there were also factions in the city who desired a peaceful capitulation and those who intended to resist. The short of it is that a capitulation to the Mongols was either retracted or seized by those who desired to resist, resulting in the sacking and destruction of Merv. Altogether, Merv was attacked and sacked three times, after which the Khwarzmshah and surviving inhabitants had attempted to reoccupy and restore the city. The destruction by the Mongols was comprehensive: the Hanafi (congregational) mosque, Sanjar's tomb, and the libraries were set on fire, the walls were destroyed, and the damn on the Murghab was broken. This effectively ended any major urban development for 200 years and terminated the prosperity of the region permanently.

Despite the destruction of the city and the population, the area was not completely abandoned and some activity seems to have persisted. The Mongol governor of the region, Arghun Aqa, allegedly restored the Seljuk palace and parks in 1247 CE/644 AH and ordered new constructions in a nearby village, but it is apparent that these developments did not result in renewed urban prosperity (Kennedy 1999).

In the early 15th CE/9th AH century, the region came under Timurid control and efforts were made to re-establish the urban prosperity of Merv. The damn was rebuilt and, instead of the old cities being rebuilt and resettled, a new, entirely square smaller (less than 1 km^2) city was built to the south, today referred to as Abd Allah Khan Kala. At this time, Merv resembled a well-equipped fortress rather than a proper city. In the early 16th century, as Timurid rule ended, the Safavids rose to power in the region, but Merv remained on the margins and its development again waned. Its urban status from this time on would be minimal. An extension was added onto the Abd Allah Khan Kala in the 18th century, named Bariam Ali Khan Kala, but by the 19th century, all of the walled areas of Merv were abandoned (Kennedy 1999).

After expanding into Central Asia throughout the 19th century, the Russian Empire arrived in the Merv Oasis in 1885 CE/1312 AH and established a garrison town there. The Russians also developed the area for agricultural purposes in the mid-20th century and some of the historic material culture of the oasis was damaged or destroyed in the process through flooding, soil removal, or outright purposeful destruction. Additionally, ground dampness and salt saturation caused by the renewed and intensified irrigated agriculture, which intensified particularly from the Kara Kum Canal constructed in 1950, also seems to have accelerated the deterioration of the standing mud-brick structures, particularly in the form of undercutting (Herrmann 1997). At times, the site also seems to have been used for military training, as there is evidence of soil being moved for fox-holes and tank-traps (Williams and Kurbansakhatov 2003).

7 See *Kitab Mu'jam al-Buldan*. In fact, the only negative thing Yaqut has to say about Merv is that the inhabitants suffered considerably from Guinea worm. If this was true and considering that this parasite is spread by copepods, this may signify the deleterious quality of the water from the source that the inhabitants were using for their water, that cisterns/pools were a major source of water and/or that the flow of the *jubs* that lined the streets was poor.

2.2.2 Historical influences on urban structure and developments

There has been much justified criticism of the scholarly idea of the 'traditional Islamic city' and the 'Arab-Islamic city' in the past few decades (Orum and Moser 2019),[8] with the central part of the critical thesis expounding upon the vast geographical area(s) of the Islamic world and the diversity of urban manifestations that inhabit it. Moreover, part of this criticism – although to a lesser extent – has attacked the idea of the "stagnant" or "unchanging" Islamic city and demonstrated how Islamic urbanism changed over time. This section will outline the socio-political influences on urban form throughout the early medieval Islamic era with an emphasis on Khurasan and Transoxiana.[9]

The influence on the form and development of Islamic urbanism can be examined from two perspectives. One is from a top-down perspective, as much of what can be said about the form and development of cities having to do with the policies and preferences of the ruling state at any given time. Following from the first perspective is naturally the bottom-up perspective, here meaning population dynamics, although it is less evident how and to what extent population dynamics had an effect on urbanism and thus often only informed conjectures can be made. However, these two perspectives should not be understood as mutually exclusive or independent from one another, as there was unquestionable pressure between the two. Perhaps this is best encapsulated by AlSayyad (1991, 153), as he writes

> *"The internal organization of each such town was negotiated between the governor of the town and its inhabitants, while its overall form resulted from negotiations between the caliph, who was concerned with enforcing the Islamic ideal of community, and the governor, who had to deal with the immediate needs of the local population."*

Within these two perspectives, there are also two facets concerning the influence on urban form and development; one pertaining to the collective or cultural concepts of ideal urbanism, and the other pertaining to the prosperity of a particular region or city. The developments outlined here should be seen in relation to the more specific historical narrative in Sections 2.1 and 2.2.2.

The era of the Umayyads (661 CE/41 AH-750 CE/132 AH) was dominated by the expansion of the caliphate, often through military means, and this is reflected in their policies towards urbanism and in form of the known examples of founded cities during their reign. In general, the Umayyads eschewed cities and urban life, especially for the soldiers stationed near existing cities, so that they would not intermingle too much with native non-Muslim populations (Dani *et al.* 1996). The supposed military camp of the Umayyad to the southeast of Gyaur Kala, Shaim Kala, may have been an example of this pattern.[10] Unfortunately, this site was destroyed by Soviet agricultural practices.

In contrast, the succeeding Abbasid Caliphate emphasised building projects, as seen by the establishment of new *masjid al-jamis* throughout Iran and Central Asia and the founding of new capitals such as Samarra and Baghdad. Additionally, the Abbasids were more open to Persian cultural influences, which was signifi-

8 Explored more in Chapter 4.

9 General or universal influences on urban form and development will be outlined in Section 2.6.3, and particular cultural influences in Chapter 3.

10 The function and date of this settlement are not known for certain. Although commonly attributed to the 7th century, there is speculation that it could date from the 8th century.

cantly evident in the architecture found throughout their realms (Baumer 2016). The structure of Abbasid cities, however, differed from Eastern Iranian patterns. The internal structure of Early Abbasid urbanism seems to have been a partial continuance of the Umayyad patterns, exhibiting proximity and orientation of government/palatial buildings and congregational mosques close to the centre of the city, ostensibly reflecting the central authority and religious role of the governor/caliph (AlSayyad 1991). This pattern is reflected in the first founded Abbasid capital, the round city of Baghdad, and the construction of the new congregational mosque and government house at Merv by Abu Muslim. The Abbasid pattern would change, however, as the elites would come to prefer constructing palatial complexes separate from cities (Northedge 2008).

Originating from the local *dihqan* aristocratic class, the Persian Tahirid and Samanid empires followed the Abbasid rule in Central Asia (Fig. 3). The suburb that would come to be Sultan Kala developed during these periods, although it is not clear how intensely. Other cities of Central Asia developed suburbs and expanded, possibly by the continual influx of the rural peasantry and *dihqans* that were drawn towards cities (Sobti 2005). Merv seems to fit the pattern of suburbanisation seen in other cities of Central Asia. Although 'Persianized', the Ghaznevid and Seljuk empires that followed the Tahirid and Samanid empires were of Turkic origin. It is during the periods of these empires that, as with Sultan Kala, some cities and suburbs of Central Asia would be walled. It is speculated that the Seljuk propensity for walls and other defensive constructions arose from their warrior and nomadic origins (Adle *et al.* 2003). However, another possibility is that since conflict between Turkic tribes was not uncommon in the late Seljuk empire, the construction of defensive walls was a practical matter.

2.2.3 Previous and current site research

Considering its historical significance and abundance of archaeological material, it is at first surprising – and unfortunate – that Merv has not received more notoriety and scholarly attention. Before the 20th century, this can probably be attributed to its remoteness, and during the last century, due to the site being within the Soviet Union and therefore only falling under purview of Soviet researchers who published mostly in Russian.

Although there had been accounts from western travellers of the Merv Oasis before, the first proper academic work on Merv was carried out by V. A. Zhukovsky in 1890. The purpose of this work was to survey and assess the damage to the monuments of the oasis caused by agricultural development brought by the newly constructed railway. In 1894, Zhukovsky published his survey of Merv, titled: *Drevnosti Zakaspiĭskogo kraya. Razvaliny Starogo Merva* [*Antiquities of the Region Beyond the Caspian Sea. Ruins of the Old Merv*] (Abdullaeva 2009).

The first archaeological excavations to be published[11] were conducted by an American expedition lead by Raphael Pumpelly in 1903 and 1904. However, this expedition focused on Gyaur Kala and the *köshks*[12] of the oasis, rather than Islamic Merv (Pumpelly 1908).

Throughout most of the rest of the 20th century, field research on Merv was conducted by researchers and projects from Russian and Turkmen institutions. In the 1930s, some excavations would continue under A. A. Marushenko and B. B.

11 The very first excavations were apparently conducted by a Russian General Komarov in 1885.

12 Referred to as "kurgans" in the publication.

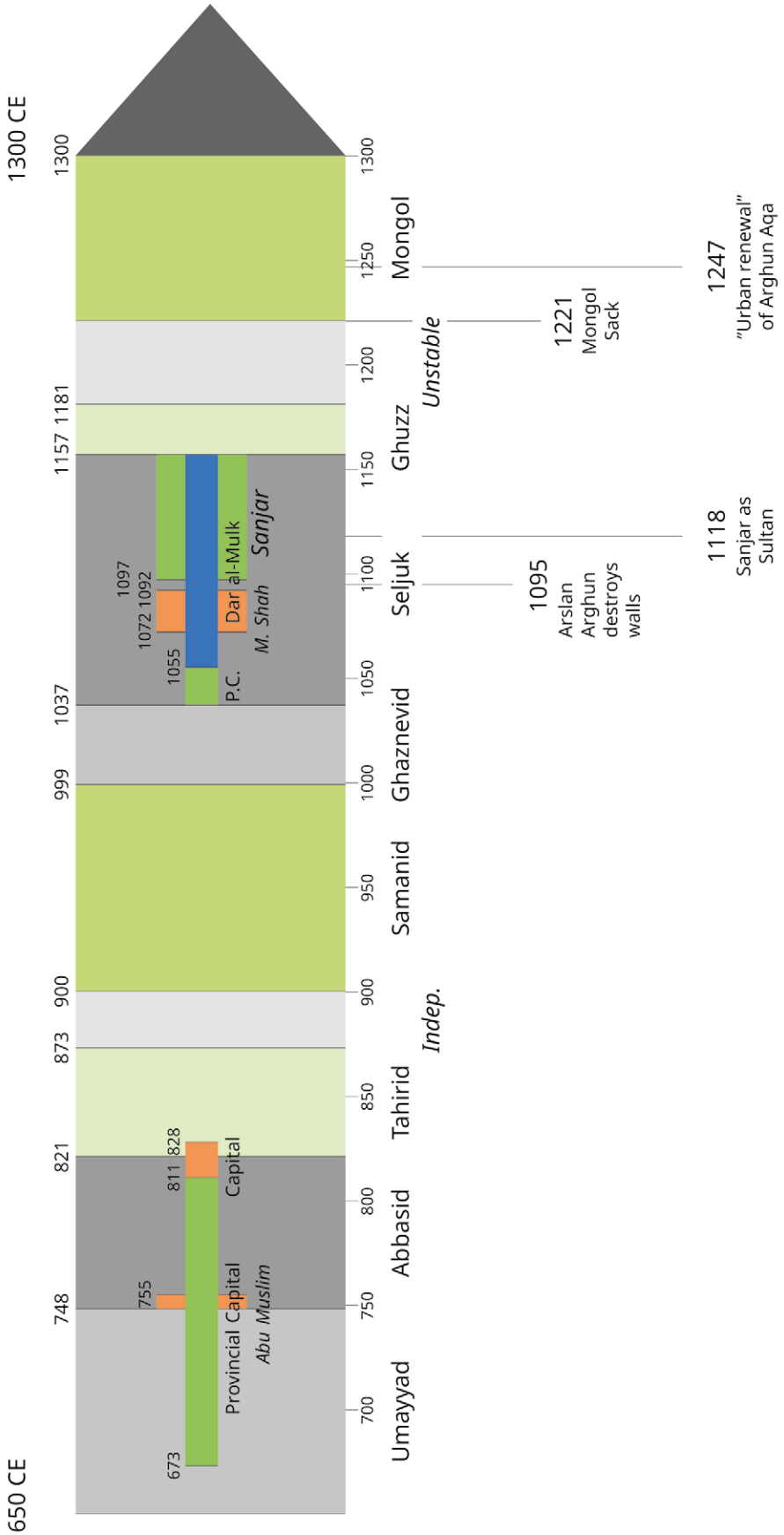

Figure 3. Timeline of Merv during the Early Islamic periods through the Mongol periods, depicting regimes, reigns of significant governors, the official status' of Merv, and significant events (Source: image created by the author).

Piotrovskii, although these would focus again on Gyaur Kala, as well as architectural surveys conducted by N. M. Bachinsky and V. I. Pilyavsky. In 1945, M. E. Masson from the History Faculty of the Central Asian State University at Tashkent established the Southern Turkmen Archaeological Complex Expedition, or YuTAKE, which continued conducting field research in the Merv Oasis, and beyond in Turkmenistan, into the 1980s. This project conducted the first significant archaeological excavations and was the first to also address the Islamic stratigraphy, excavating not only Sutlan Kala, but the other Islamic sites of Abdullah Khan Kala and its extension Bariam Ali Khan Kala. Under this project, Sultan Kala was aerially photographed extensively during the 1970s, providing a valuable accompaniment to the topographic maps that had been made. Over the course of decades, this project produced ample material on the Merv Oasis. Unfortunately, much of the material – published and unpublished – is difficult to locate as it is in the archives of the Turkmen authorities at Tashkent, and some at St. Petersburg (Williams and Kurbansakhatov 2003). In 1989, a survey of the northern Merv Oasis was initiated by the Instituto Italiano per il Medio ed Estremo Oriente Rome (IsMEO), which is still current. Although this project focused on early periods, it has also helped to map the canal system and the many *köshks* that dot the landscape (Bader *et al.* 1994).

In 1991, just after the dissolution of the Soviet Union that facilitated new ventures between east and west, the International Merv Project (IMP) was established. Under direction of Georgina Herrmann of the Institute of Archaeology at University College London (UCL) and St John Simpson of the British Museum, this project was a collaboration between those institutions and, at the time, YuTAKE. The IMP was conducted until 2000 and had a broad scope, carrying out field and architectural surveys, excavations, and ceramic analyses on all of the urban sites (though focusing on Erk Kala, Gyaur Kala, and Sultan Kala with investigations on the latter from 1994) (Herrmann *et al.* 2001). In 1999, Herrmann published her volume on the history and structure of Merv, titled: *Monuments of Merv: Traditional Buildings of the Karakum*, which is an essential read for any investigation into the history and archaeology of Merv.

In 2001, a new project in the same spirit as the IMP was initiated, the Ancient Merv Project (AMP). Once again, it was a British and Turkmen collaboration under the auspices of the Institute of Archaeology at UCL and the National Department for the Protection, Study and Restoration of Historical and Cultural Monuments within the Ministry of Culture of Turkmenistan, with Tim Williams and Kakamurad Kurbansakhatov as directors from the two respective institutions just mentioned. Unlike previous projects, the AMP focused most of its attention on Sultan Kala, medieval Islamic Merv. In addition to traditional archaeological methods of research, an aim of this project from the beginning was to construct an interactive geographic information systems (GIS) base map of the urban topography. The IKONOS satellite image was commissioned for this purpose. However, the resolution from IKONOS was not sufficient to map the topography of cities (Williams 2012).

In 2010, the AMP began to photographically survey the urban sites using unmanned aerial vehicles (UAV). The surveys were carried out by Gai Jorayev – who would later become the deputy director of the AMP – for his PhD thesis at the time, but his surveys have continued in varying years until as recently as 2019. The data that resulted from the surveys, the details of which will be described in the relevant section below, is a central source for the present work, as it enables the analysis of the topography of the urban sites and the assessment of its increasing deterioration.

Also starting in 2018, Tim Williams launched the Central Asian Archaeological Landscapes (CAAL) project, which aims, among other things, at collecting, digitising, and cataloguing current archives that contain archaeological material throughout the region. His efforts have digitised and translated some of the aforementioned YuTAKE material on Merv, some of which has also been a source of this work.

Chapter 3: Urban morphology: Theory, approaches, and models

3.1 Introduction

3.1.1 Premises

Before reviewing pertinent urban morphological theories, it is necessary to outline certain base concepts upon which the studies of social geography and urban morphology rely. The first concept is the reciprocal relationship between the patterns of built environment and social ideas/behaviours. This concept may seem self-evident, but the particulars of how this reciprocal effect works and leads to different development trajectories of the built environment is less so. This is evidenced by the numerous theories and bodies of approaches for analyses and interpretations of the built environment. The second concerns the trajectory and forms that the built environment take. It is the observation that embedded, past built-environmental forms are superimposed in the fabrics of towns and cities in what are called 'palimpsests' in analogy to past texts that are visible in reused manuscripts. While there are clear examples of this being factual, the degree to which the palimpsests can be interpreted or 'read' accurately can vary depending on circumstantial conditions and researchers' degree of perspicacity.

3.2 Overview of urban morphology

3.2.1 Defining the study of 'urban morphology'

As this study draws heavily from the analytical approaches found within urban morphology, it is necessary here to delineate the field of study to better understand its aims. Definitions of urban morphology vary and tend to correlate with the theoretical approach in use for a particular piece of work or researcher. A common, though not exclusive tendency is the interchangeable use of the terms 'form' and 'morphology', and unsatisfactorily, it is not uncommon to have the term 'form' in the definition itself (Oliveira 2016). The reason, in part, that approaches – and therefore definitions of urban morphology – vary is that the study of urban morphology is found within different related disciplines such as town planning, urban design, social and historical geography, architecture, and more. Because various analytical and theoretical approaches are presented in this section, a comprehensive definition is provided here. But rather than contributing a newly composed definition, it will suffice to supply a quote from Kropf (2017, 9):

> *"Urban morphology is the study of human settlements, their structure and the process of their formation and transformation."*[13]

Although cities may be the crux of urban morphological studies, as suggested by the former definition, the term connotes settlements more generally in urban morphology (Kropf 2009).[14]

By 'form' or 'morphology', what is meant is the physical pattern of combined constituent elements and spatial units that comprise a city.

Although urban aspects, elements, and spatial units will be discussed further later in this chapter, the most commonly used terms referring to these elements require definition before continuing.[15] For example, one of the most commonly used terms is 'fabric', synonymous with the equally frequently used term 'tissue'. Fabric and tissue refer to the hierarchical pattern of urban elements: building materials, structures, buildings, plots,[16] streets, and blocks (or 'plot series'). These elements are what comprise larger scale urban spatial units such as 'zone', 'district', 'neighbourhood', and 'quarter'. With non-urban morphologists, these terms can easily become conflated. 'Zone' is a blanket term for large areas such as the latter three. The term 'neighbourhood' refers to predominantly residential urban areas with a higher likelihood of face-to-face interaction. They are usually socially, spatially, and morphologically distinct in some way, yet due to the fluid nature of social relationships and interaction, they may have no clearly identifiable definite boundaries. 'District' is a top-down municipal administrative designation for areas that are usually larger than neighbourhoods and may be comprised of a few of these (Smith 2010). The term 'quarter' is not often used in urban morphological studies, especially as an element used for analysis, but it will feature as an urban spatial unit in this study. Like the 'district', quarters are usually comprised of multi-

13 It may be useful to add to this definition that the 'agents' of urban processes are also part of the field of study (Oliveira 2019).

14 However, it could probably be argued that a requirement for settlements of study is that they are at least semi-permanent.

15 These terms, along with others, will of course also appear in the Glossary.

16 Since plots are not used as an element of analysis in this study, the 'plot' can be simply defined as a 'small bound piece of property'. But look to Kropf (2009) for a discussion of the ambiguities of the plot.

ple neighbourhoods and can function semi-independently from the rest of the city in that they will have commercial and civic amenities. Unlike districts, however, they usually do not have an administrative function, may be physically bound, and often have distinct cultural or ethnic characteristics. With the possible exception of the 'neighbourhood', the components just discussed are not particular to cities, but are the common aspects considered characteristic of them and their study.

3.3 Defining 'the city'

In order to review the breadth of thought on urban form, it is first necessary to consider the various concepts of what the city is and how it has been, and can be, defined. As with many other conceptual phenomena, such as the 'state' or 'culture', defining the 'city' and 'urbanism' by simply listing physical and absolute attributes is woefully inadequate for universal application; variability is inherent in conceptual phenomena and cases will inevitably be found that do not adhere well, or at all, to the attributes listed. Yet attribute lists can offer some guiding principles in urban analysis, but principally only when looking at specific regions or city types.[17] In his work on ancient/historic cities, V. Gordon Childe (1950) famously outlined what he considered to be the attributes of the pre-industrial city and Kostof (1992) likewise draws from these in his own attribute list.

Childe

1. In relation to other settlements, cities are densely populated, and large in area and population.
2. Heterogeneity of the urban population in the form of vertical differentiation and specialization.
3. Production of capital through taxes or tithes of production surplus.
4. Monumental public constructions.
5. Those serving the state – that is, those that do not produce for themselves are supported with the surplus.
6. Record keeping and advanced mathematical systems.
7. Writing system.
8. Symbolic art.
9. Inter-regional/long distance trade.
10. Community membership based on residency rather than kinship.

Kostof

1. Places of "energized crowding" (Kostof 1992, 37) which results in a higher settlement density.
2. Cities are a part of an "urban system" (*ibid*, 38) with other dependent settlements.
3. Places that have material or symbolic "physical circumscription" (*ibid*, 38) to distinguish residents/citizens.
4. Heterogeneity of the urban population in the form of social hierarchies from specialization as well as some level of ethnic diversity.

17 This kind of urban modelling will be discussed in Chapters 3 and 4.

5. Cities are special sources of income through trade, surplus, or proximity to a natural resource.
6. Written records or some form of record keeping.
7. Cities have territories or countrysides which provide goods, usually in the form of food, and to which the city provides services.
8. Public and civic monumental constructions which provide a sense of identity and place for the populace.
9. Cities are places of "buildings and people", and along with their form, function, and meaning should be considered a whole.

Whether from an architectural, geographical, or sociological perspective, cities are most commonly defined with positive attributions – what they are – rather than with negative attributions – what they are not. For relevant purposes here, only definitions that entail robust physical consequences/manifestations will be discussed.[18]

Population size, density, and sedentariness have commonly been noted as significant attributes of cities, although absolute figures are now eschewed in favour of relative quantities and qualities. Illustrative of this is the often-cited quote of Wirth (1938, 8) for an adequate simple definition of the city as

> *"a relatively large, dense, and permanent*[19] *settlement of socially heterogeneous individuals."*

Somewhat related to this concept of the city, especially in terms of (population) largeness, is that cities are impersonal settlements; it is a particular aspect of cities that inhabitants will often encounter others with whom they are unfamiliar and have little or no personal relationship (Hillier and Hanson 1989).

Although using feature lists for definitions is commonly considered outmoded in the social sciences, they do yet appear. For example, Marcus and Sabloff (2008, 13) present their own list of commonly referenced urban elements in order to define the city:

1. Heterogeneous people, occupations, crafts, classes, and statuses.
2. Diverse political, social, religious, economic, and administrative buildings, institutions, wards, neighbourhoods, and associated personnel.
3. Dense packing or crowding of residential and non-residential structures.
4. A monumental core of unique buildings (for example, a cathedral or temple, a library, a palace, a central market, a courthouse, or a set of administrative buildings).
5. A skyline or "city profile" that shows maximum building height at the centre of the city and less and less height as one moves away from the city centre.

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18 This is in contrast to Marcus and Sabloff's (2008) citation of *The World of Cities: Places in Comparative and Historical Perspective* (Orum and Chen 2003), in which they essentially summarise the latter authors' argument/definition of cities being places with meaning, or having the quality of 'placeness'. While it has some enlightening concepts, this definition appears too abstract for practical archaeological use. Additionally, the opinion of the author of this thesis is that the quality of 'placeness', or the city as a place imbued with meaning, does not seem specific to cities (though it is conceivable that the city could be defined/described as a space with a hierarchy of heterogeneous meaning-imbued places).

19 There is even a question of validity with permanent sedentism being a steadfast feature of cities, as some pre-colonial Southern African urban sites may indicate "mobile cities" (Chirikure 2020) if they were indeed cities.

Attributes	Type of Variable	Inclusion in Other Lists
Settlement Size		
population	M	
area	M	
density	M	
Social Impact (urban functions)		
royal palace	P/A	Renfrew; Flannery
royal or high aristocratic burials	P/A	Renfrew; Flannery
large (high-order) temples	P/A	Renfrew; Flannery
civic architecture	S	
craft production	S	Renfrew
market or shops	S	Weber
Built Environment		
fortifications	P/A	Renfrew; Weber
gates	P/A	
connective infrastructure	P/A	
intermediate-order temples	P/A	
residences, lower elite	P/A	
formal public space	P/A	Renfrew
planning of epicenter	P/A	Renfrew
Social and Economic Features		
burials, lower elite	P/A	
social diversity (nonclass)	P/A	
neighborhoods	P/A	Renfrew
agriculture within settlement	P/A	
imports	S	

Table 1. Urban attributes. Type of variable: M: quantitative measurement; P/A: presence/absence; S: measurement scale (1: low; 2: moderate; 3: high) (after Smith 2016, 159).

6. A central focus – sometimes a sacred centre – whose access was restricted and where temples predominated, and sometimes an administrative centre where governmental buildings were concentrated.
7. Special organisational features, such as grid-like modules with city blocks, streets, city walls, ward or barrio walls, canals, sewers, aqueducts, parks, and public squares.

This list does not so much present elements that help to define the city, as it presents some elements and features that are associated with cities. These are useful, however, in that they are features that can be used to identify and investigate urban sites from an archaeological perspective, albeit with some exception to the "city profile".

In attribute lists, the features/elements are not necessarily equally weighted concerning their association to the city. Particular aspects associated with cities, such as large population size or density, may be considered integral to cities. It has been maintained, for example, that in relation to the street as public space, "without it, there is no city" (Kostof 1992, 194). Like feature lists, placing essence on one aspect also seems overly simplified and prone to real and conceivable exceptions.[20]

Used in specific ways, attribute lists aid in defining and identifying cities, especially in archaeology. Smith (2016) proposes using attributes to identify cities in a diagnostic way, though he refers to this as a polythetic method. In this method, Smith provides a list of urban attributes that are either present or absent, measurable, or scalable, and a certain number (and presumably degree with the measured and scalable attributes) of attributes that must be met for a settlement to be considered a city. However, he points out that this method is better for determining the scale of 'urbanness' in a settlement rather than a simple negative/positive identification, and he therefore sets no specific quality or number to his proposed attributes (Table 1).

3.4 Variation between cities

In attempting to understand universal patterns of urbanism, cities have been classified in various terms, contingent on specific aspects of urbanism. These aspects on which the classifications rely are discussed in either morphological or functional terms.

3.4.1 'Organic' vs. planned

Perhaps the most simplified and abstract morphological scheme of classification within urban studies is that of the dichotomy between 'organic' or irregular[21] and planned cities. In this scheme, irregular cities are those that have spontaneously accreted over time due mostly to the aggregate will of individuals. As a result, these types of cities tend to morphologically look non-geometrical, with amorphous outlines and crooked streets, and hence the designation 'organic' or irregular (Kostof 1999). In morphological and architectural terms, irregular cities are apt to be more influenced by environmental conditions, such as natural topography, than planned cities (Morris 1994).

In contrast, planned cities are created in a short period of time and with intention, usually by some authority or governing body. Such cities – especially pre-modern examples – are morphologically geometrical, with the simplest and possibly commonest form being the grid, typified by streets at right angles and architectural standardisation (Smith 2007). However, other forms have occurred, for example, the circle with radiating streets – early Baghdad being a prime example – and various polygons (Kostof 1999).

In practice, however, there is no clear distinction between these two categories, rather the scheme is graduated. On the one hand, no city or built environment can strictly be described as 'unplanned'. Individuals and groups unarguably have foresight and purpose in constructing, and to varying degrees there is inevitable

20 An argument against the centrality of streets, in the strict sense, could be that is seems that Mayan cities lacked them.

21 Irregular is the term preferred here in opposition to 'planned' in that the use of 'organic' implies that coherent orderly forms do not occur in nature and that humans are therefore separate enterprises.

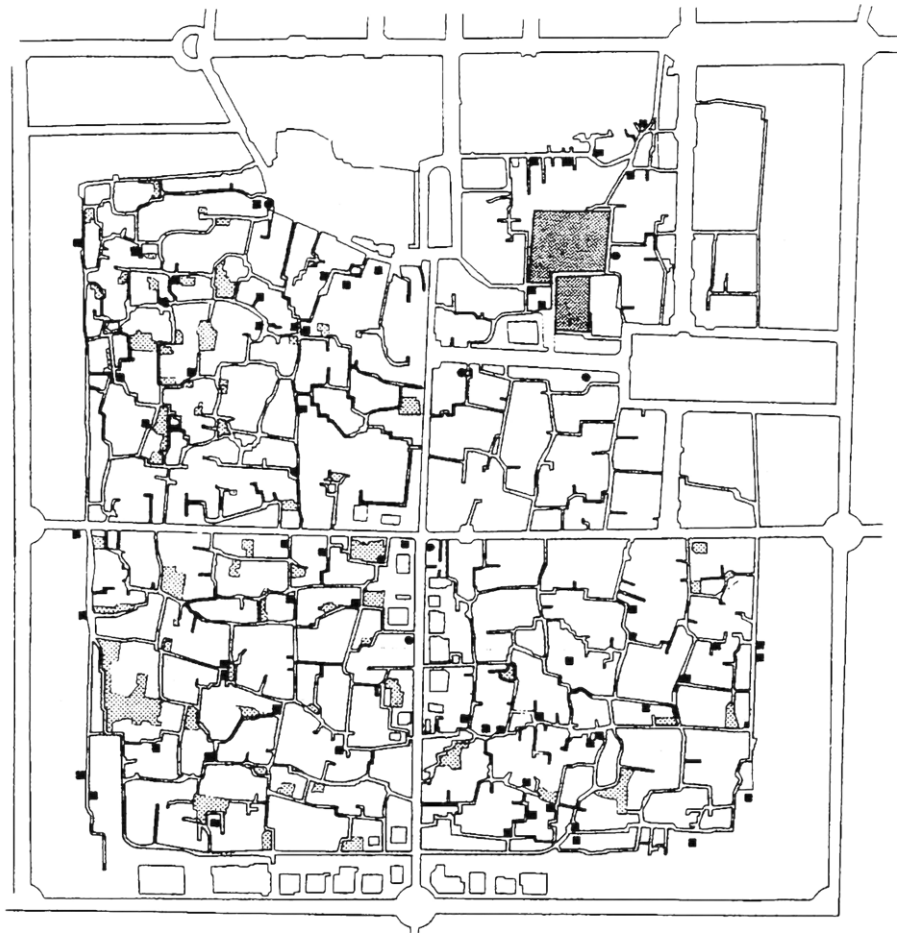

Figure 4. The old city of Herat (after Gangler *et al.* 2004, 35).

negotiating between different parties concerning control and access (Kropf 2009). On the other hand, the regularity of cities that have been willed by higher authorities are prone to "degrade" over time, as consecutive negotiations are made, and environmental and social conditions change. In the words of Kropf (2009, 106),

> *"cities are the result of deliberate and coordinated human effort* [...] *and exhibit characteristics of 'self-organization' and emergent behaviour."*

In cities where central authorities have more control over city-wide municipal matters, the development of irregularity tends to be slower than in urban systems which leave municipal affairs to local communities. This process can be seen in the morphology of late antique Roman cities in which the defined regularity of the streets and blocks gradually yielded to bent passages and amorphous blocks. Cities commonly display discernible 'palimpsests' with planned and spontaneous elements, especially those with long histories. A good example of this is Herat (Fig. 4), in which the outward form of the city and its primary streets are geometric and were certainly designed. Its internal tissue, however, is irregular which indicates vernacular planning and construction. An additional argument against the 'organic' and 'planned' scheme is that it assumes a connection between orthogonality and formal planning, which is not a universal concept but particularly western (Smith 2007). This dual scheme is, therefore, more valuable in determining palimpsests and the direction of the cause of development in western urbanism, than in categorising settlements.

A more practical approach to urban planning in pre-modern cities is the dual scheme that has been proposed by Smith (2007). In his scheme, rather than the degree of planning being represented by a single scale, Smith proposes multiple scales for the different facets of 'planning'. Ordinal scales are used to measure the coordinated arrangement of structures and spaces, formality and monumentality, and standardisation. This scheme more accurately addresses the multifaceted character of urban planning, has the advantage of being measurable, and can be applied to assess the meaning of planned urban elements.

3.4.2 Pre-industrial vs. post-industrial urbanism

Within the historical social sciences, a generic distinction is often made between pre-industrial and post-industrial, or on occasion less explicitly between 'ancient' and 'modern' cities, yet that both share enough social characteristics to unify them under the same phenomenon which we designate as 'city' (Smith and Lobo 2019). This distinction can be made from the vantage of morphological or functional aspects of urbanism, the latter of which can also be separated into socio-cultural and economic aspects. Unsurprisingly, these aspects have a causal relationship, with functional aspects having a heavy influence on morphology. Functional aspects were more influential on the morphology of pre-industrial cities, as post-industrial cities are overwhelmingly economic in function and less influenced by environmental determinants due to technology. One perhaps obvious aspect of pre-industrial cities was the prevalence for the need of proximity to required amenities, due to restrictions in mobility, which often resulted in compact or high density tissues.[22] The lack of specialisation in land-use has been claimed to be a feature of pre-industrial cities (Kostof 1999), although this does not appear to be particularly universally accurate; one can easily find examples in pre-industrial cities of land being designated for production, agriculture, ritual, commerce, and other particular purposes. However, there was indeed a greater correlation between land-use and ownership, such that it was more common for occupational work and home to occupy the same space. Although housing is inherent to all forms of urbanism, it overshadowed other forms of space in pre-industrial cities, so much so that house groups are a more persistent pattern than public spaces (Kostof 1999). The need for defence, which is not a concern for modern cities, also had an influential effect on the form of many pre-industrial cities, resulting in them being in topographically strategic locations and bound within walls of defensive geometric patterns.

What is significant about the difference between pre-industrial and post-industrial urbanism, which affected both the morphology of cities and how they functioned, is the primary institutional purpose that pre-industrial cities served within the context of their respective geographical areas and settlement systems. Pre-industrial cities expressed a wider variety of functional purposes than post-industrial cities that are almost solely economic in function (Smith and Lobo 2019). This difference prompts another topic in the study of pre-industrial urbanism, that of city types.

22 This is perhaps more of a western pattern in urban morphology. Mesoamerican urbanism, particularly Maya urbanism, is a notable exception.

3.4.3 Urban typologies

There have been many typologies for urban settlements proposed in the history of urban academic studies. Market towns, port towns, capitals, primate cities, regal-ritual cities, consumer cities, and producer cities are just some examples of urban settlement types that have been suggested. It would be superfluous in the present study to outline the numerous typologies that have been proposed, but they can be broadly characterised as either being completely or nearly universal – seeking to be applicable to all cities – or theme specific (Smith 2016). In either characterisation, however, the typologies derive from the functional aspects of urban settlements.[23]

This array of typologies is problematic in that it does not readily make patterns of urban settlement functions evident, and does not clearly address overlap in functions. For example, there was commonly not a clear distinction between secular and religious power in pre-modern times, so typologies such as 'capital city' or 'ceremonial centre' lack important nuances (Kostof 1992). In his generalised scheme, Smith (2016) groups cities into two broad types: economic cities and political cities. The latter category is further subdivided into the two overlapping categories of 'regal-ritual' and 'capital' cities (Fig. 5), with the former expressing cities on the more functionally 'religious' end of the spectrum, and the latter on the more 'administrative' end. The simplicity of this scheme allows it to be comprehensive, while the two-dimensional continuum addresses the overlapping nuance of urban functions.

From a modern perspective in which most cities function economically, the relation of function typologies of urbanism to urban morphology may seem oblique, but the primary function of urban settlements in pre-modern urbanism had a significant influence on their form and development. Most pre-industrial cities were political in function (Smith 2016; Smith and Lobo 2019), suggesting that their development and status were heavily influenced by their symbolism. In contrast, most pre-industrial urban settlements that mainly had an economic function tended to be small market towns (Kostof 1992). Elements of political urban form were apt to be a product of formal and/or standardised planning in pre-industrial cities, and were frequently the result of the will of a select few agents with power (*i.e.* elites and rulers). Particularly relevant to this study, mid-level[24] meaning in politically influenced elements of urban form can be seen in medieval Islamic cities. Clear examples of meaning can be seen in the spatial orientation of congregational mosques and *Dar al-Imaras,* and more specifically, the purported form of medieval Baghdad in which the caliphal palace and congregational mosque were located at the centre of the circular city. Settlement status, prosperity, and development are also greatly influenced by political agents. The administrative status of a settlement has a direct effect on the required urban amenities of the said settlement, and the higher the administrative status of a settlement, the greater the fundamental tendency for it to attract commerce and population growth.

23 'Primate' cities are a partial exception, as they are distinguished by their relative size in relation to other settlements within the same system in addition to their function(s).

24 This is in reference to the scheme initially advanced by Rapoport (1982) and presented in Smith (2007) for application to the built environment. This scheme is comprised of three levels of meaning: 1) high-level, related to cosmological and sacred concepts, 2) mid-level, which presents identity, status, and power, and 3) low-level, which deals with the reciprocal relationship between the built environment and human behaviour.

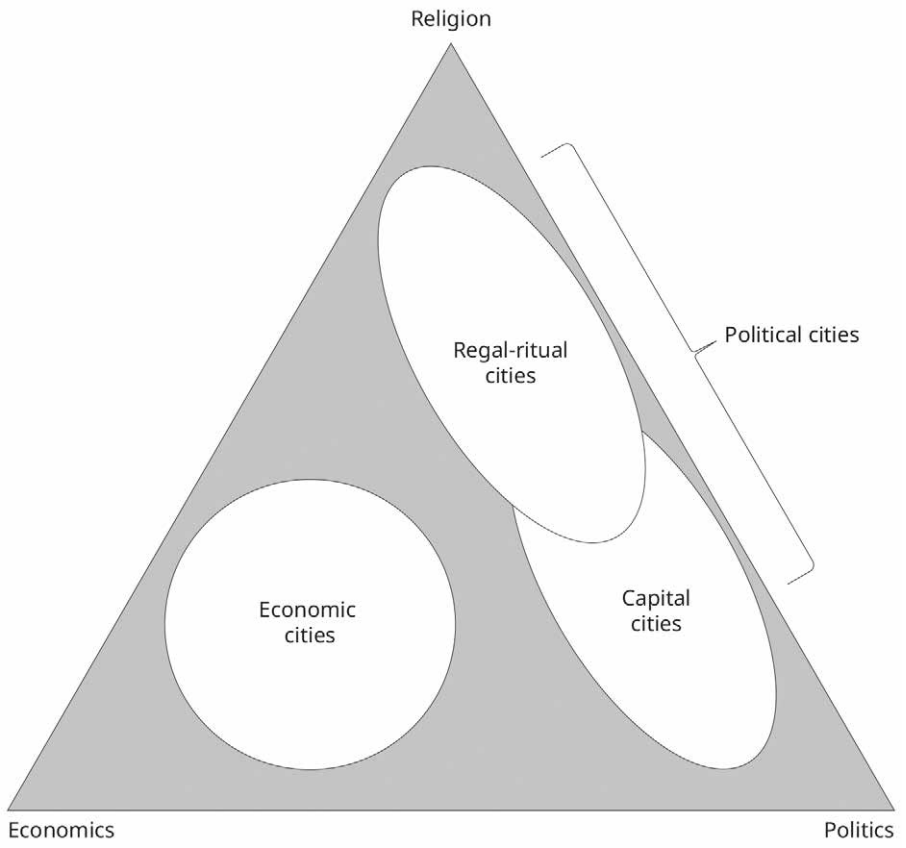

Figure 5. Types of premodern cities (after Smith 2016, 164).

3.4.4 Elements and aspects of urban form

What is meant by the 'elements' of urban form are the constituent features that compose the built environment and which are the units of urban morphological analysis. 'Aspects' refers to the choice of elements used for analysis, how to define these elements, and the scale or resolution of examination. There are essentially two genres or approaches to urban elements – those that are minimally descriptive, exclusively in reference to physical form, and those that can convey both function and physical form.

Fundamental to both of these genres are the concepts of the 'edge' or boundary, however superficial it might seem. Edges/boundaries refer to both physical partitions as well as conceived and ambiguous boundaries. The concept of the edge/boundary is crucial for the analysis of urban structure at every scale, be it from the scale of rooms to the limits of the city, as it is interdependent with the idea of 'space' (Kropf 2017). Both require the other for definition, and many of the elements of urban analysis can be subsumed as types of spaces.

The descriptive set of elements are few and simple: solids, voids, built-up areas, and occasionally lines. This set of elements is utilised in the configurational analytical approach which seeks to understand control of movement in the built environment. It is also useful, however, as the basis on which more functional implicit elemental schemes can be applied in order to make interpretive analysis more transparent.

The functional elements vary in terminology and specificity/complexity depending on the approach and scale(s) of analysis. Beginning with the functionally

specific, voids can be divided into street spaces/circulations system (which include areas such as squares/piazzas), open spaces, and rooms (Kropf 2017). While these latter elements also seem descriptively minimal, there is some degree of function or land-use implied. For example, open space suggests areas that are outside, but not a part of the street system (e.g. gardens, green-spaces, courtyards, *etc.*). However, the elements most commonly used are streets, buildings, plots, and blocks/plot series. Purely in terms of form, streets, or alternatively 'paths', especially reveal past development stages of urban settlements as they are particularly stable (Oliveira 2016). Once the plan of a street has been established, it does not tend to change drastically.

Listing the numerous functional elements, which appear in scholarly composition, would be ponderous and unnecessary here. The characteristic of functional elements that needs to be considered and retained is that their use often conflates both form and land-use (function). A prime example of this is the term 'single-family house' (Lynch 1981), but this fusion can even be applied to the street. Streets are generally conceived of as relatively lengthy and narrow polygons, but inherent in them is their use for intra-urban movement. There are further uses for streets that might be conflated such as public interaction and commerce. Another danger in merging form and function is that function/use/activities co-occur and are fickler than the built environment (Kropf 2009). As with the street, a built space might have multiple uses that may or may not coincide with its 'formal' function, or the function itself of that space can change. The permeability between land-use and form can muddy the comprehension of the built-environment (Kropf 2009), and so it is necessary to combat this in the method of analysis by separating function and form where possible (*i.e.* using both functional and descriptive elements) and being explicit in what aspects of elements are being analysed and interpreted.

3.5 Models

With the aim of making universal generalisations about cities, a number of conceptual models of cities have been put forward in the history of urban studies – mostly over the course of the last century. Many of the most influential ones developed out of the "Chicago School" of urban studies, and as will be shown, these models are largely based on one another, or use similar analytical approaches. In their analytical aspect, these models are largely descriptive, though there are some basic causal explanatory qualities to them. This may be due to the conflation of "land-use" and social-economic analytical elements implicit to the models. These types of models described in this section have been widely criticised for being over simplistic, and their inability to describe every urban type and city (Marcus and Sabloff 2008) – a criticism that is common in most, if not all, conceptual models. Additionally, for the present context, the caveat must be presented that these models were based on post-industrial cities, although this is not so much a criticism as they may still have application on pre-modern cities, as has been attempted (Eger 2013). Yet, these models have some value in their simplicity, in that they are intuitive, and thus provide a point of departure to discuss other analytical methods and approaches.

1. Concentric

Developed by Park and Burgess (Park *et al.* 1925), the concentric model, as the name suggests, is formed on the notion that cities develop in phased bands (or

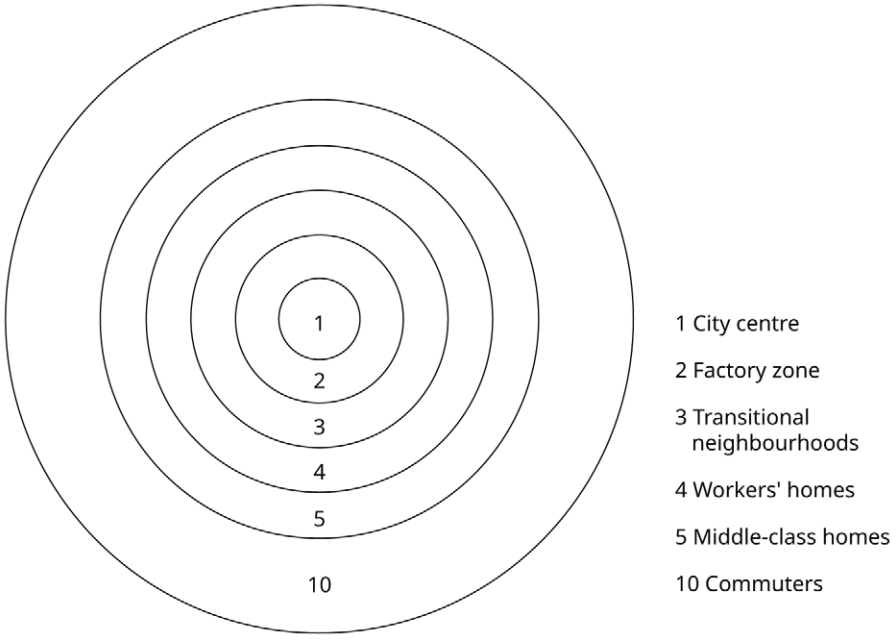

Figure 6. The concentric model of the city (after Marcus and Sabloff 2008, 6).

zones) that radiate outward from a centre as the city grows, much like the wave pattern formed by dropping a pebble into a pond (Fig. 6). In this model, the zones are mostly based on a land-use categorisation theme: the centre, which may – but not necessarily – be the original settlement, is primarily the 'business' district, which is then surrounded by the 'factory' district. Following are successive types of residential districts: neighbourhoods of factory workers and laborers, middle- and upper-class neighbourhoods, and finally a zone of commuter neighbourhoods.

This model can, and has been, both criticised and merited for its simplicity (Marcus and Sabloff 2008). On the one hand, urban zones are, in reality, not consistently homogeneous in land-use and outward growth as the model portrays, and thus the physical form of the outward development does not manifest in neatly outward radiating rings. On the other hand, the model does dissolve the concept of urban growth and form into the simplest conceptual parts, and so is a good broad applicable concept for initial rudimentary urban analysis.

2. Sector

The sector model is somewhat of an enhanced counterpart to the concentric model. As with the concentric model, the sector model is also established around a "city centre", the difference being in the way the different land-use/functional areas develop. The land-use categories are generally the same or similar, but rather than areas of land-use getting re-appropriated for other uses as a city develops – and thus forming 'rings' of development – in the sector model, areas tend to maintain their initial land-use/function and develop in wedges that radiate from the city centre (Fig. 7; see Hoyt 1939).

Being more nuanced, the sector model offers more insight into the particulars of the development of cities, but at the expense of likely being less widely applicable. It has the additional advantage, however, of being combined with the concentric model and thus provides an even more refined model for urban analysis (Marcus and Sabloff 2008).

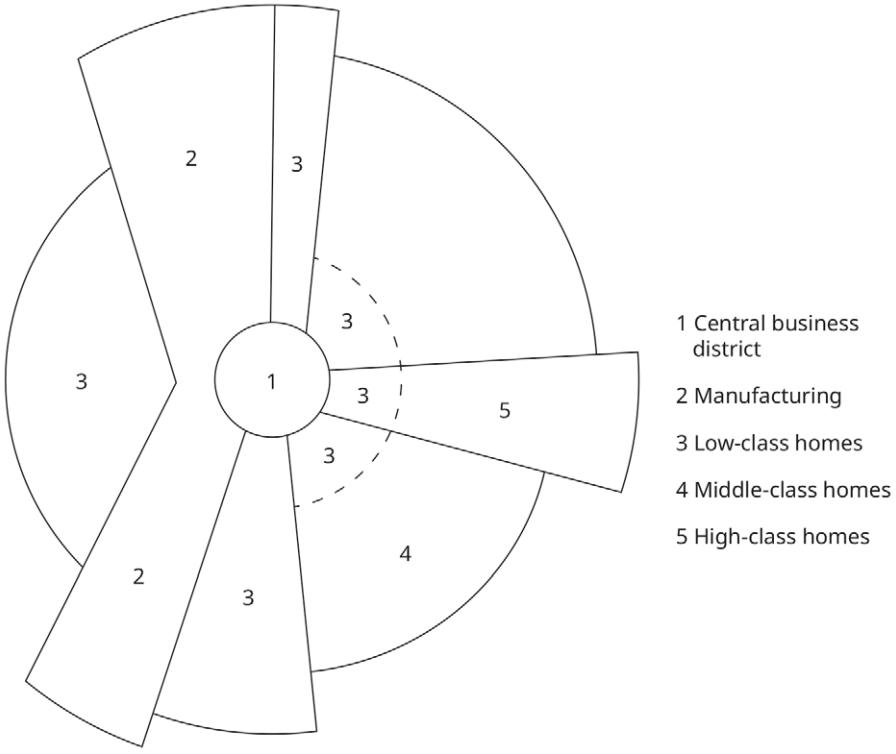

Figure 7. The sector model as proposed by Hoyt (1939; after Marcus and Sabloff 2008, 7).

3. Multiple-nuclei

This model implies a decentralised and irregular urban form. Here multiple 'centres' and zones, which have a predominating land-use/function, coexist within an urban system. The different centres/zones can be 'original' in the urban system, or could have developed from a more centralised city over time (Fig. 8). This model seems to describe a different urban system from the other two, but still may be complementary if it can describe and/or explain the development of an urban system from centralised to decentralised.

It must be stressed again that these models were developed to describe modern/post-industrial cities, particularly in the United States, and so their application for pre-industrial urbanism may be limited or misleading. Yet, as in his analysis of medieval Antioch, A. A. Eger (2013) discusses the three models described above and their applicability to describe the development and morphology of the city. In the paper, he posits that a combination of the concentric and multiple-nuclei models parallel the concept of the traditional 'Islamic city',[25] in that according to this concept, Islamic cities tend to have largely independent/self-reliant neighbourhoods and quarters centred around a civic core. However, he argues that this scheme does not bear out when applied to Antioch, as archaeological excavations have not found evidence of a civic core. Instead, he argues that the sector model is a better match for the city's morphology, with different zones situated along axial routes. While this conclusion is compelling, caution should be taken with the suitability of the sector model to universally describe medieval Islamic urbanism.

25 To be discussed in detail in Chapter 4: Islamic urbanism and the 'traditional Islamic city'.

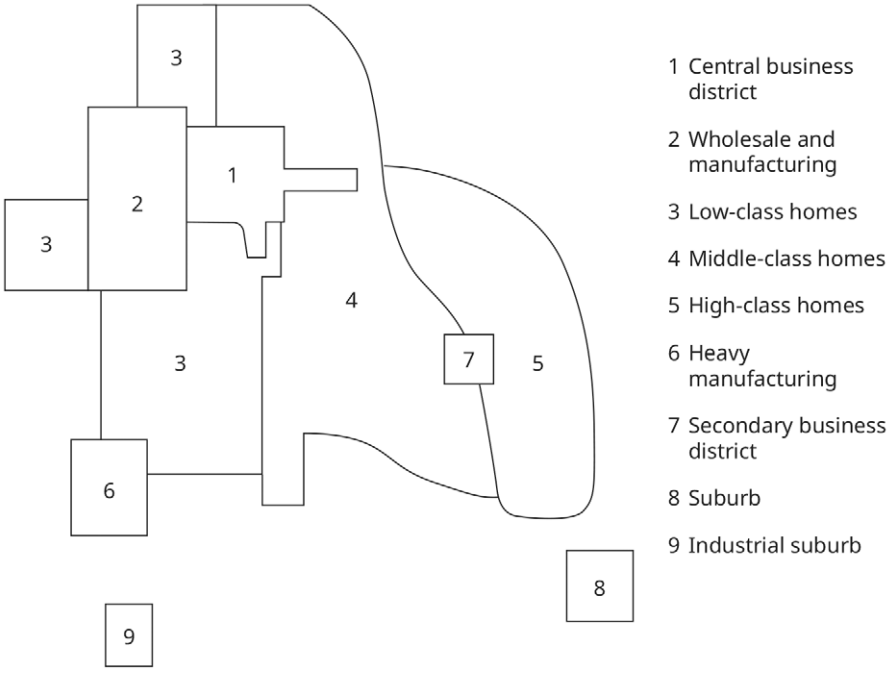

Figure 8. The multiple nuclei model (after Marcus and Sabloff 2008, 9).

3.6 Analytical Approaches

3.6.1 According to Kropf

While not exhausting the full scope of urban morphological methods and theories (for this, see Lynch 1981), Kropf (2009) does well in summarising them into four categorical approaches.

1. Spatial analytical approach

Rather than focusing on architectural form or fabric, as is more present in the other approaches, this approach instead emphasises the dynamics of spatial distribution of land-use and agents. Due to the emphasis on dynamics and change, this approach is very model driven, meaning that the 'morphology' emerges from rules by which the agents and structures are governed. This approach is not applicable to this research and would likely have limited applicability to archaeological cases in general for the following reason. While it is made clear that the models associated with this approach are not meant to be 'predictive', they are intended to describe morphological growth based on core mechanisms. In archaeological cases, the process is essentially reversed, that is, one attempts to derive the mechanisms from the morphology.

2. Configurational approach

What Kropf means by the configurational approach is the body of analytical methods known as space syntax (Hillier and Hanson 1989) (although it is conceivable that network analysis could also be slotted into this category). Unlike the previous approach, Space Syntax is more reliant on built form, as its main analytical focus is the relationship between form and movement. A range of different urban scales can be analysed with this approach, from single structures commonly represented by j-graphs, to entire cityscapes usually expressed by axial

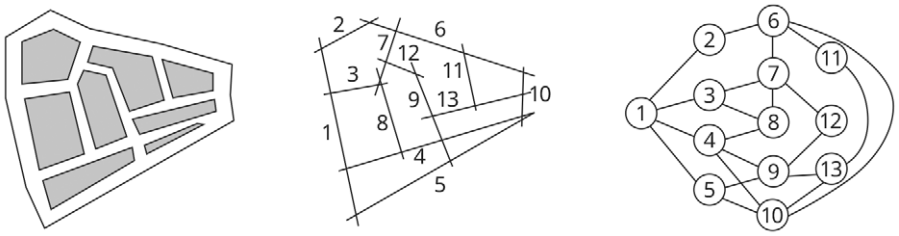

Figure 9. Graphical representations used in space syntax. Urban environment (left), axial graph (centre), j-graph (right) (after Porta *et al.* 2006, 714).

graphs (Fig. 9). Although Space Syntax is one of the few urban morphological theories that has had an accepted – if limited – use in some architecturally oriented archaeological research, it is not applicable in the present research. The axial methods, which would be most applicable for the scale of this research (with a neighbourhood to city-wide scope), rely heavily on precise measurements of the voids between built units, which is not the resolution which is available with the data available in this research.

3. Process typological approach

This approach analyses both the spatial (co-presence) and temporal (derivation) (Caniggia and Maffei 2001) relationship of architectural elements of an urban tissue. The spatial analysis is applied to different scales of the urban system, beginning with building materials of individual structures and extending to urban regions. This is conducted by organising urban features at different scales into hierarchical sets: elements, structures of elements, systems of structures, and organisms of systems (Kropf 2009). As the designation of this approach suggests, arrangements at different scales are designated as types. Significantly, types are associated with dynamic cultural ideas of urban elements, in that the function of the element is preconceived to satisfy human requirements and is modified along with cultural processes.

This approach appears to bear some promising schemes for archaeological application from moderate (building aggregates) to large (urban tissue) scales. It is especially attractive to understand diachronic urban development. However, at finer scales, its application could be problematic, depending on site conditions and the kind of surveyed data (that is, from excavations or various surveys). This pertains to the data resolution, kind of data, and conditions of the present case studies.

4. Historic-geographical approach

This approach is epitomised by the concept of townscape, which is itself comprised of three physical elements: the town-plan, the building fabric, and land and building use patterns (Conzen 2018). Town-plan analysis realised by M. R. G. Conzen in his study of Alnwick (Conzen 1960) is the core method in this approach, and is aimed at understanding the development of urban settlements through patterns in accumulated forms. In this method, by relying heavily on detailed cadastral maps, a 'plan' of the 'townscape' in question is then transcribed that highlights the following urban elements: the street system, the plot pattern, and the building pattern. 'Plots' in this context are defined as properties and their respective boundaries, and so have both the attributes of form and land-use. Patterns of combinations of the urban elements are used to form larger elements, called 'plan-units', which are meant to express areas of urban development during a certain historical duration (Fig. 10). Differing patterns in the combinations of these elements – or rather urban/building fabrics – are identified as separate morpho-

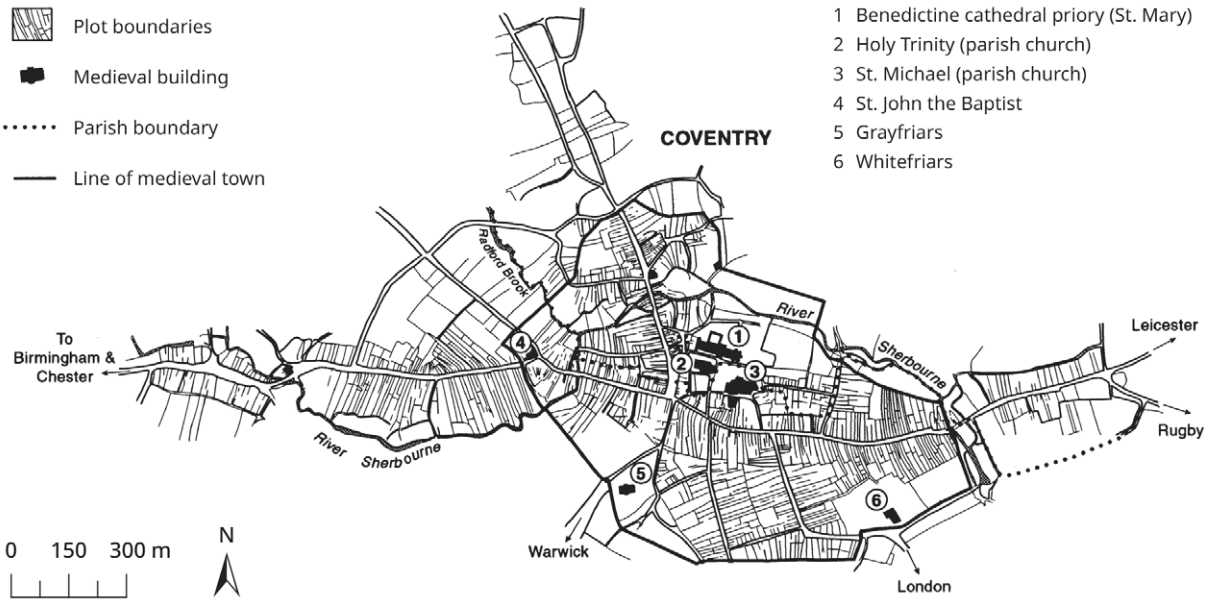

Figure 10. An example of town-plan analysis using 'plan units' (after Lilley 2000, 12).

logical regions. Intrinsic to this method is that the separate morphological region/building fabrics represent periods of development and/or re-development.

In recognising patterns and defining plan-units, more kinds of data other than physical form may be incorporated into the analysis, for example, written and archaeological data. The incorporation of other data enables conclusions on development to be robust, but by what morphological parameters the plan-units are bounded at times is not made clear and thus appears arbitrary. Additionally, as Kropf (2009) notes, the conflation of land-use and form in the definition of the plot leads to ambiguities in the analyses. Yet the intuitive aspect of identifying morpho-temporal units coupled with its simplicity makes this approach promising for archaeological applications, with the caveat of unspecific parameters by which elements and units are made clear and explicit. Moreover, in most archaeological cases, it is not possible to identify 'plots' in terms of ownership, so a different definition would have to be formulated or another identifiable element used in lieu of the plot.

3.6.2 Gauthier and Gilliland

A useful scheme to understand the variety of different urban morphological theoretical approaches has been proposed by Gauthier and Gilliland (2006). Rather than classifying different theoretical approaches based solely on distinct historical schools or the manner of analysis – as other schemes that do this will be discussed below – P. Gauthier and J. Gilliliand's (*ibid.*) scheme organises theoretical approaches by philosophical aspects. This scheme also has an additional advantage of illustrating the degree of emphasis and overlap between categories by means of 'mapping' on a cartesian grid. For the present aim here, however, it will suffice to cover and discuss the scheme and its categories without the map, as not all categories are directly relevant to this study.

The scheme consists of two pairs of classes on two axes, as in a cartesian grid. The classes of the pairs can be considered as being mutually antithetical.

1. Cognitive versus normative

Theories in the cognitive approach seek to describe and, moreover, to provide explanations of urban morphologies, their development, and transformations. Naturally, much of historical geography concerned with urbanism falls under this class and within which some of the works of M. R. G. Conzen and Kostof can be placed. In contrast, normative approaches are prescriptive with the aim to devise sound principles for urban planning and development.

2. Internalist and externalist

The internalist approach to urban morphological theory views the urban process as a self-regulating independent system of relations between elements. In other words, there are rules for the arrangement of elements, how they interact, and change. This view necessitates that urban elements are not discrete objects and that the relations between the elements are not by chance. Contrastingly, the externalist approach emphasises urban form as the product of human (cultural, social, historical, perceptual) and geographical 'determinants'.

For the purposes of this study, it is most relevant to assume an approach that is situated on the cognitive side of the scale, with consideration of both the externalist and internalist views. However, any considerations following the internalist approach will be more speculative, as specificity in this view relies heavily on all the scales of urban elemental forms, and the details at the scale of building fabric are absent from the corpus of data on Merv. Externalist considerations are more conducive for general conclusions, and thus more applicable to low resolution cases.

3.6.3 Urban development

3.6.3.1 Drivers and determinants of urban development

Time and the process of change are central to urban morphological theory. Even in the cases where settlements are formally planned and created 'momentarily', the growth of all urban settlements is cumulative; "settlements are [...] polymorphogenic accretionary artefacts" (Kropf 2017, 88). When considering change in the built environment, the terms 'development', 'process', 'transformation', and the like, are often used without specific definition or interchangeably. Therefore, it is useful to define and make a distinction between urban 'development' and 'evolution', as these are the preferred terms for change in this study. As pundits of human behaviour through materiality, these concepts will be familiar to archaeologists. 'Development' refers to the history of change of an entity, such as a building or an entire settlement, from its formation to its abandonment and decay. 'Evolution' pertains to the changes in ideas and resultant types of entities. The distinction can be likened to the difference made in biology between 'ontogeny' and 'phylogeny' (Kropf 2011). Naturally, these two aspects of urban process are interconnected. Evolution can happen as an accumulative response to social or environmental changes through gradual changes (development) in individual entities. Development also occurs in response to social and environmental changes, but also arises more tangibly from the actions and wills of individual or groups of agents. For the purposes of this study on an individual city, emphasis is placed on urban development.

The forces that affect the formation and development of urban settlements, referred to as 'determinants', can be divided into two classes: environmental[26] and human. In terms of the environment, Morris (1994) identifies three attributes: the natural topography, climate, and materials and technology. The effect that topography[27] has on urban form and development seem fairly intuitive. Major natural features, such as lakes, rivers, and mountains, naturally make their impression on the form of settlements. Relief in the terrain can also have a significant effect, as streets typically follow the contours of the land. As a rule of thumb, the more uneven the natural topography, the more likely the built urban system will be irregular (Kostof 1999). The opposite does not necessarily bear out, however. Even terrain will facilitate geometrically regular urban forms, but it is not forceful on the horizontal built system.

The effects of climate and building materials/technology are more readily comprehensible at smaller scales of urban form, such as architecture, although they can have a cumulative effect at larger scales such as the urban tissue/fabric. Naturally, the way in which the climatic effect on architecture and urban form is manifested is subject to the specific climate conditions of a particular geographic region. For example, houses with rooms located around central courtyards are common in hot arid regions such as the Mediterranean and the Near East. This vernacular architectural style developed to assuage the heat by providing shade and air flow. It is often maintained that the preferred and common orientation for such houses in Iran is NNE-SSW, where rooms on the latter side are used during the summer for shelter from the sun, and rooms on the former to receive the sun's warmth through the courtyard (Tavassoli 2016). This vernacular architectural arrangement can indeed effect urban tissue and form if sufficiently adhered to.

Before the industrial era, construction materials for settlements were largely restricted by local availability of natural resources. The materials used were exclusively earth (either sun-dried or fired), stone, or timber. Instinctively, materials do affect architecture and the urban building fabric, mostly in aesthetics and structural constraints, but primarily from a lateral perspective. They generally would not be expected to have much influence on urban tissue from a plan perspective. Overall, environmental determinants constrain or put limitations on the way urban systems develop in contrast to human derived determinants, as environmental attributes are more static. Put another way, environmental determinants are the base developmental forces on which human derived determinants and processes further develop the urban system.

Human derived determinants are more abundant, complex, and dynamic than those that are environmental. Broadly, there are three 'primary motivating forces' behind urban form and development: economics, politics, and religion (Morris 1994), although it should be kept in mind that the latter two were mostly inseparable at the state level in the pre-industrial world.

While economics was not necessarily the 'primary motivating force' behind all pre-industrial cities, there is general consensus that a surplus of foodstuffs, either through import or by production, is a precondition of any city. The formation of many 'spontaneous' cities was due to an advantageous geographical location that would enable them to produce or trade surplus goods. Favourable circumstances

26 Oliveira (2016) considers the environment, or "natural context" in his words, as an element of urban morphology.

27 Location is a related attribute to topography for urban development, but is more related to settlement origins and so is not so pertinent here.

could then nurture further growth. This is evident in many port cities and medieval Silk Road cities.

As noted before, it is difficult to separate religion from politics in the pre-modern world, and so they should be considered nearly the same 'force' concerning administrative or state level society. The prosperity of premodern settlements, and therefore their ability to develop intensely, predominantly relied on their political status. For instance, although capitals tended to be consumer cities due to a need for the provision of administrative/state entities and enterprises, the infrastructure required support of the administration/state, whereby the symbolism to legitimise it often drove monumental or expansive constructions. Structures for major defence, opulence, and communal worship were more often than not the direct result of the presence of the central state. The symbolism of the political status of a settlement itself could affect its allure, and thus the population size and structural development (Kostof 1999; 1992). The extreme expression of this are those capitals and urban centres that have been entirely formally planned and constructed such as Baghdad and Samarra.

There are few instances where religion by itself can be identified as the primary urban developmental force. Early settlements that have grown from ceremonial centres are one example. Another example can be observed in the form of spaces of local worship such as parishes and local mosques (Kostof 1992). Religiously derived law and legislation have also prescribed built form and development. An apparent example of this is represented by the rules and regulations for the dimensions of streets and public spaces in traditional Islamic cities. However, even in this case, it is disputable whether the catalyst for the rules are religiously, culturally, or politically derived.

3.6.3.2 Forms of development and evolution

It is easy to succumb to perceiving a connotation of growth or positive directional change – in both physical structure and social complexity – with the use of 'development', but caution to avoid this connotation should be taken as is confounds an understanding of urban processes. The connotation lacks the nuances of urban development, even in the cases where it can be positively said that the general trend of a settlement's development was positive. In built environments, deterioration is persistent – presumably more pervasive the larger the settlement – and urban development is a process of interaction between deterioration, preservation (Kostof 1992), and novel construction. This process is most apparent at the scales of city and building fabric, and it is conceivable that it was more acceptable and apparent in pre-modern urbanism. Fustat provides a case where it was common for ruined structures to be scattered throughout the city (Kostof 1992; Goitein 1969). This interactive process pervades all the manifestations of urban development at larger scales. Yet, growth is a common part of urban development, and it is the aspect of development that is most easily discernible at larger scales, and therefore will be given special attention.

There are broadly three aspects to urban growth; repletion, replacement, and accretion (Conzen 2018). One of the most intuitive forms of urban development is repletion, basically meaning the process of 'infill' (Kostof 1992). Unless designated and preserved, empty space in cities is re-purposed for structures as it increasingly becomes sparse. The increased scarcity of empty space may not necessarily be only due to population increase/pressure, but also to reuse or re-purposing spaces in

confined urban areas as well. This can occur in 'cycles' in particular urban localities, given the right circumstances of land ownership (Conzen 2018).

Replacement is the process of supplanting existing structures with new ones. This either occurs from bottom up at the individual and local level, or from top down due to some formal administrative planning. This occurs due to changing social situations and requirements (Conzen 2018).

Accretion is also a fairly intuitive process. As available space for new development becomes scarce in the built-up areas of an urban settlement, new constructions are created on the undeveloped periphery of the settlement, if there are no physical spatial constraints. The process of accretion prompted the concept of 'fringe belts'. These are strips of urban development that depict sporadic periods of growth of a settlement, and as such, display distinct urban tissues. As a simple analogy, the process and depiction can be likened to the rings on the cross section of a tree trunk, although with a settlement there need not be equal outward growth (Whitehand 1988). An influencing factor for the morphology of successive belts are 'fixation lines', which are linear features, such as a town wall or road, which represent an earlier peripheral border of a settlement. The concept of fringe belts mostly developed out of the growth analysis of urban settlements of Europe from the early Industrial Revolution, but has recently been applied to medieval Europe with Como as the case (Conzen 2018), and to China with Nanjing (Whitehand and Gu 2017).

The last notable manifestation of urban development to be discussed is 'synoecism'. Derived from Greek and meaning roughly 'to dwell together', this term originally referred to the process of nearby ancient Greek villages and towns coalescing into *poleis*. The term now can refer to two similar but distinct processes. One is approximately the same as the original sense and is specifically referred to as 'conurbation'; the process of the fusing of adjacent settlements into a single urban unit due to outward growth. In the other process, a newly established settlement can absorb the populations of nearby settlements due to a lack of space and a change of social situations. Examples of such processes have occurred in ancient Mesopotamia, and in Islamic lands such as Iran (Kostof 1999).

Chapter 4: Islamic urbanism and the 'traditional Islamic city'

4.1 Introduction

The intent in this section is to survey and discuss the concepts of the Islamic city / Islamic urbanism, including both historically emic concepts and scholarly concepts. However, as this is a dense topic of study with a long – and somewhat contentious – history, this section is not exhaustive, nor is there an attempt to contribute significantly to the scholarly discourse. The aim, then, is to situate the case studies of this thesis within a cultural context and scholarly perspective.

A commentary must first be made concerning the use of 'Islamic' and related terms in connection with cities and urbanism. As will be made clearer through further elaboration below, over the latter part of the scholarship on the topic, the role (if any) of religion in Islamic urbanism and even the existence of distinctively characteristic Islamic urbanism has been questioned and revised. Accordingly, the appropriateness of the terminology on this topic has been under deliberation. The adjective 'Muslim' is occasionally used in lieu of 'Islamic' when referring to cities/urbanism, and has been argued to be more appropriate in this context. However, it is difficult to see how this "corrects" the issue, as both adjectives in English are used to refer to something within Islam, as well as being an awkward application of the term (it would be unusual to refer to 'Muslim art'). To seemingly divert the focus from religion and to narrow the geographical/cultural scope, the adjective 'Arabic' is also used in connection with cities/urbanism, but is conceptually conflated with 'Islamic cities/urbanism.' Arguing that 'Islamic cities' are a part of a broader set of

'Middle Eastern urban systems', Eugen Wirth has preferred to use 'Oriental city' (Raymond 2008). It is here concurred that the term 'Islamic cities' likely does fit within a system of Middle Eastern urbanism, but the overall position held in this study is that any adjectival designation for an object simply needs to be distinctly defined with parameters that are appropriate for the particular study.

The 'Islamic city' as a distinct form of urbanism has itself been questioned in the course of the scholarship on the subject. The objection to 'Islamic urbanism' derives in part from the scepticism about the degree to which religion has influenced urban morphology. There is no doubt that ritual living patterns affect spatial organisation and architecture, but distinguishing between the influences of culture, practical matters, politics, and religion can be difficult or unproductive. For instance, many of the building principals outlined by B. S. Hakim (2008), such as dimension requirements for passages and streets, seem to be more practical than rooted in religion. To illustrate this, it has been noted that many of the qualities often attributed to Islamic cities were also shared with medieval European cities (AlSayyad 1991). To add to the scepticism, much of the idea of the 'Islamic city' has derived from analysis on historically late 'traditional' Arab cities, and in turn this has raised inquiry into how and to what extent Islamic urbanism has evolved and is regionally variable (Abu-Lughod 1987). Similarly, with the use of a single term applied to cities that can be found in such the great geographical expanse that Islam has reached, there is the danger in overlooking regional urban traditions.

Despite the often-deserved scholarly scrutiny that the concept of the 'Islamic city' has received, it persists as a topic of study, perhaps because it is a useful topic of analysis (Wolper 2014). In this study, the terms 'Islamic city' and 'Islamic **urbanism'** will be used, but not to necessarily imply that cities are distinctive through the quality of being 'Islamic', but to refer to cities situated predominantly in the sphere of Islamic social and political influence. Additionally, while temporal and regional differences are important issues of study, they are only so in order to reveal any possible shared patterns by means of comparison. This chapter, therefore, will outline many of the commonly identified elements, features, and qualities of urban settlements through much of Islamic history and geographic associated regions.

4.2 City and settlement system concepts in the medieval Islamic world

Since it has been demonstrated earlier that no universal concept or definition of the 'city' can be established, and that the designation of the city is contextually reliant, it would therefore be misguided to apply modern and western concepts of urbanism to the analysis of the 'city' in the relevant time and cultural context. While it may not be possible to take a completely emic perspective of medieval Islamic and Central Asian urbanism, a review of the concepts and designations of urbanism of the time will help narrow the conceptual disparity. The designation or names of physical features/components within a structured vocabulary reflect the form, function, purpose, and possibly use of the features.

This is what B. S. Hakim (2008) describes as a *design language*. Vocabulary pertaining to cities and settlements of the time can be gleaned from historiographies and authors of travel accounts. The most widely known and used sources for the Middle Islamic medieval period is al-Muqaddasi (945 CE/334 AH-991 CE/381 AH, also commonly known as al-Maqdisi), although others such as Yaqut (1179 CE/575 AH-1229 CE/626 AH), ibn-Hawqal (943 CE/331 AH-978 CE/368 AH), al-Masudi

(896 CE/283 AH-956 CE/345 AH), al-Istakhri (850 CE/236 AH-957 CE/346 AH), and Ya'qubi (second half of the 9th century CE/3rd century AH) are also useful sources.

As one might expect, much of the Arabic vocabulary for settlements and architecture does not have an exact equivalence in English vocabulary. This is readily demonstrated with the term *madinah*, which can most closely be translated to 'city' used in general terms (or perhaps also 'town' which is used in the parlance of the United Kingdom for urban status) (Wheatley 2001), or 'urban settlement' according to B. S. Hakim (2008). Wheatley (2001, 511) is more specific, noting differing uses of the term:

> *"originally, seat of government; subsequently, an inner, usually walled city; in al-Maqdisi's technical terminology, a district capital, usually in a politically and/or ecologically marginal situation."*

The term could also be used to distinguish the old or original settlement from a *rabad* (suburb) that subsequently developed nearby (B. S. Hakim 2008). The criteria for the status of 'city'/*madinah* for the Early and Middle Islamic periods is usually sourced from Muqaddasi's *Ahsan al-Taqasim fi Ma'rifat al-Aqalim*, as there is overlap in the criteria with other medieval authors (Wheatley 2001) and therefore likely reflects a commonly held concepts of 'citiness'. Although al-Muqaddasi never explicitly defined the criteria, it is clear that he required both a congregational mosque (*jami*) and a market (*suq*) for a settlement to be considered a city. In fact, he claims that villages and towns could only be distinguished by the lack of a mosque in the former (Kennedy 2006).

In discussing the use of primary sources, Wheatley notes that there were differences in the use of settlement related terms among medieval authors, and that they were well aware of the ambivalence in the designation of urban status of some settlements. Muqaddasi's list of criteria is comparatively narrow, and other authors required additional services for city status, such as the presence of a governor or *Qadi* (judge) with a 'palace' (*Dar al-Imara*), and/or a public bath (*hammam*). Al-Muqaddasi is more explicit in hierarchically classifying urban settlements and the primary source for examining medieval Islamic urban settlement systems (B. S. Hakim 2008; Wheatley 2001). His ranked settlement system scheme is as follows:

1. Misr (pl. *amsar*)

Simply translated as metropolis (B. S. Hakim 2008). The definition of this term is outlined well by Wheatley (2001, 512), as he explains the differing uses:

> *"This word for city long preserved the implication of border warfare inherent in its ancient Semitic root. As such it denoted the military cantonments established as bases for the Arab armies during the conquests, a meaning retained by lexicographers as late as the tenth century: a city lying on the boundary between two countries. At the same time, lawyers defined it as a large urban settlement with a resident governor in which legal punishments were administered, having a tax base adequate for its needs, and overseeing a supportive rural district. In popular speech misr denoted any large and important city. In Muqaddasi's technical terminology it signified the locale where the supreme ruler of a territory resided, where fiscal administration was situated, and which exerted a dominant influence over all other urban centers in an iqlim." (transl. author: climate/geographical area)*

Supposedly, the common informal use of this term was for any large and important urban settlement (Sobti 2005). In Muqaddasi's count, they numbered seventeen, and included Samarqand and Nishapur (Wheatley 2001).

2. Qasabah

Often translated and defined as a provincial capital, without further elaboration. However, in actual usage the term could refer to a principal or fortified settlement (Luz 1997). Muqaddasi does provide a list of sixty-two place names in which Merv is also included.

3. Madina (pl. *mudun/mada'in*)

According to Muqaddasi, these served as 'district capitals' for 'dependencies', presumably for the caliphate or the Islamic realm in general. Expanding upon this, Wheatly observes that these cities have an 'uneven distribution' and mostly occurred in marginal border areas such as Khurusan and Transonxiana. This association might then explain why they unexpectedly count far fewer than the *qasabat*.

4. Qaryah

The meaning of this term is mostly used for villages (B. S. Hakim 2008), hamlets (Wheatley 2001), or similar settlements. However, al-Muqaddasi's usage of this term is problematic as he includes settlements of a wide range of sizes and functions within this category, and Wheatley argues that this might be due to that some settlements "must have been a composite of several ranks" (Wheatley 2001, 78).

Special attention should be given here to a few important points and observations about the scheme outlined above. Firstly, because this scheme is sourced from Muqaddasi through Wheatley, the scope of time that it is applicable is limited at most to Wheatley's period of study (7th-10th century CE). It is expected that some semantic shift and change in usage would have occurred through the Early, Middle, and Late Islamic periods with different administrations associated with the rise of different caliphates and states. Secondly, it is also likely that this scheme was used universally for the Islamic realms and some regional variation, especially in lands that were not traditionally Arabic speaking like Greater Iran and Central Asia. Thirdly, the above criteria for urban rank appear to be heavily focused on the administrative status of the settlement (B. S. Hakim 2008), which seems to have been reliant on the category of territory that the settlement served (province, district, *etc.*) and likely the status of the elite in charge (governor, *qadi*, *etc.*). It does not, explicitly or even ostensibly, consider size in the urban ranking and settlement designation as other authors of the time do, although the descriptions of the sizes of settlements are mostly indicated in vague terms such as 'large' or 'well populated' (Walker 2011) for the category of *misr* or sometimes *qasabah*. Fourthly, apart from the criterion of *suq*, there is no attention given to other urban civic services/amenities and institutions, which also appear in other written sources (B. S. Hakim 2008; Walker 2011; Wheatley 2001). It has been shown above in Section 3.4.4 on urban models that complexity and specialisation of civic services is essential for urbanism, or 'citiness'.

At this point, a question should arise: Is there any correlation between settlement size in population, complexity (quantity and quality) of civic services, degree of government administration, and terminology? Naturally, this is somewhat

a rhetorical question, as any attempt to gauge these parameters in the distant past would be problematic. However, the question should raise the understanding that the urban status of settlements was likely a complex combination of these parameters and, furthermore, relative and contextual. Using the criteria of *jami* and a permanent *suq* alone results in ambiguities and exceptions, as in the numerous fortified manor-like settlements found in Khurusan and *Ma Wara an-Nahr* and large caravansarais in Greater Iran that contained both *jamis* and *suqs* but likely had small, village-sized populations (Sobti 2005). Concerning size, it is conceivable that a large city might be designated as a *qasabah*, while another smaller city would be referred to as a *misr* based on the presence of a provincial governor. Additionally, in the Early Islamic period, it seems that geographical location was a factor in a settlement's designation, as with the *amsar* and *mudun/mada'in*, a factor which does not immediately seem to play a role in common English urban classification schemes.

That Muqaddasi's criteria seem comparatively narrow by chiefly emphasising the level of territorial administration likely reflects what the minimum requirements were for the definition of a city in official bureaucratic usage. The meaning in this sense appears to have endured over time and across different administrations, from the Abbasid period in Muqaddasi's time, through to the Seljuk and Mamluk periods of administration. In informal/vernacular contexts, the usage of urban related terms was likely more fluid and did not necessarily correspond with usage in formal civic circumstances. As evidenced by other sources, population size was considered a factor in the designation of a settlement as urban (*misr* or *medina*) (B. S. Hakim 2008; Walker 2011). For illustrative purposes, a rough analogy of these meanings/usages and those used in modern English is provided here. A rank-size classification is commonly used in vernacular English when referring to urban settlement status, *e.g.* (metropolis), city, town, village, and hamlet. However, in official legal contexts, the use of 'city', or 'township' or 'borough' in British English generally refers to a self-governing municipality.

Although the use of trait lists in analysing Islamic urbanism is oversimplistic for scholarly purposes in the study of Islamic cities, the listed features express a traditional conception of the city and should be scrutinised. It is noteworthy that Muqaddasi's minimum requirements for a *medina* were a congregation mosque and a market. No fully adequate analogy can be made between these criteria and usage to modern English, but a very loose comparison could be made to Middle and Early Modern English – 'towns' required the presence of a market, and 'boroughs' or 'cities' required a cathedral (Kostof 1992). This is somewhat at odds with Morris (1994). He argues that while there was a similarity in the requirements for urban status between Europe and Islam, in that the presence of a church and market were significant, the requirement for a governor and/or *qadi* is unique to Islam.

However, a parallel could be argued for cathedral cities, as these are the seats of bishops.

4.3 Form and arrangement

While the Orientalist thesis has been adequately and rightly criticised, and even the veracity of the existence of the 'Islamic city' questioned, it will be useful here to review the very general observations about the form of 'traditional' cities in the Islamic world from North Africa to Central Asia. However, it should be noted that these observations are primarily based on the Late Islamic periods (that is, modern

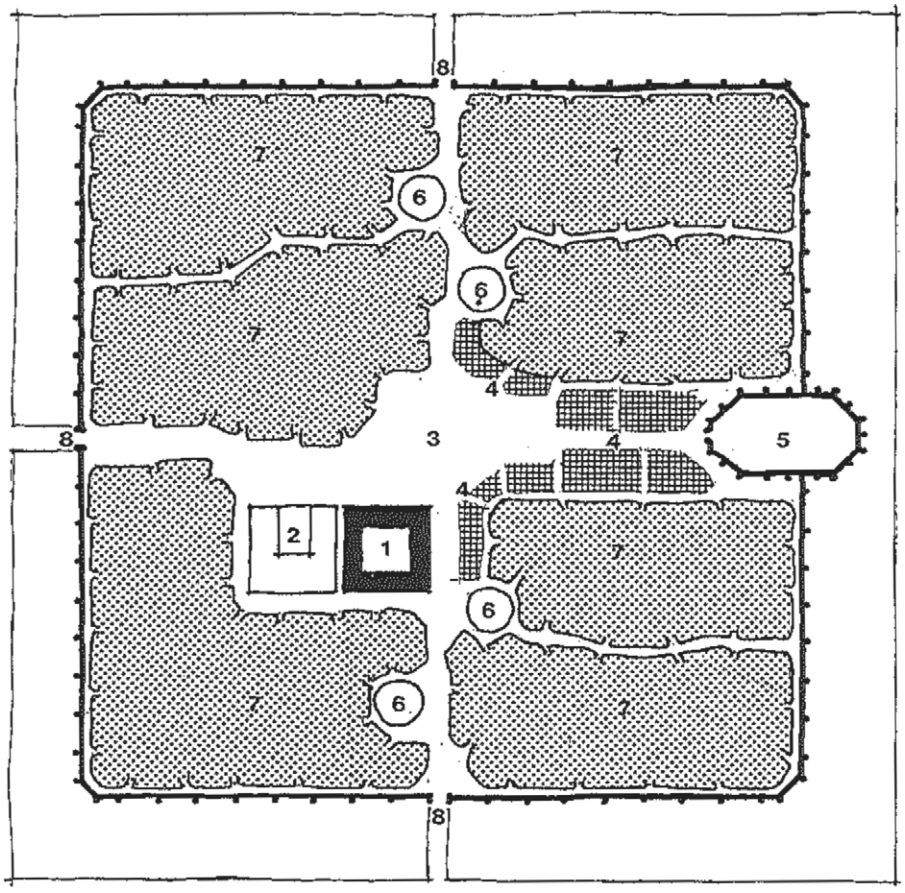

Figure 11. A stereotypical Islamic city (after AlSayyad 1991, 22).

but pre-industrial), and are mostly influenced by the concept of 'Arab' city form (North African and, naturally, Arabia). By form, what is meant is the 'shape' a city assumes by the spatial arrangement of its constituent architectural features and elements. The architectural and functional characteristics of the urban elements and features themselves are discussed in detail in another section.

As noted before, in addition to referring to district capital cities, *medinah* also denotes the central or older original district of a city. In addition to residential areas, *medinah* is most commonly the section of the city where the *jami*, the primary *suq*, and main madrasa are located. This is also where the *Dar al-Imara* would have been located in the Early Islamic Umayyad and Abbasid periods. These former urban institutions are often in the centre of the *medinah*, though not necessarily, thus *jamis* in many cities are located near the periphery of the *medinah*, particularly close to a city gate. From the Seljuk periods forth and mostly in cities found in North Africa and Arabia, the *medinah* commonly had a surrounding wall *sur*, which was chiefly symbolic rather than truly defensive. The gates (*abwab*, sing. *bab*) of the wall are also significant nodes of traffic where secondary *suqs* are often located (Bianca 2000). The later suburban developments of the city beyond the *medinah* are the *rabads*. These too could also be enclosed by their own walls. The *kasbah* was also commonly attached or adjacent to the city walls of the *medinah*, although there are cases where it is outside the city, such as Fustat-Cairo, or less commonly, within the *medinah* due to urban expansion (Morris 1995; B. S.

Hakim 2008). Early in a city's history, the *musalla* was also often located outside the *medinah*, beyond the city walls if present. The *musalla* is a large open space for the male populace to assemble for the Eid festival prayers or other special occasions. In certain cases, incremental urban expansion would enclose the *musalla* making it more like a large city square. Almost invariably, the *musalla* was in close proximity to the *jami*, and therefore often near or in the centre of the *medinah* (Morris 1994).

Perhaps one of the most significant features of Islamic cites is the division of the *medinah* and the *rabads* into residential quarters, or *mahallat* (sing. *mahalla*). These quarters primarily separated different ethno-religious communities of the city. It was previously common for cities to have Jewish and Christian quarters as well as possibly quarters of differing ethnic Muslim communities found throughout Islamic lands, such as Persians, Turkomans, Kurds, Sogdians, *etc*. In some earlier cities, the communal distinction could even be finer, with different Arab tribes and clans occupying their own quarters (Bianca 2000). The Abbasid urban settlements of Samarra are a prime example of this, with their many ethnic designated cantonments and neighbourhoods (Northedge 2008). The *mahallas* in some cities were also walled off from each other and even gated and locked at night (Morris 1995). Craft industries were also commonly grouped together in their own districts, especially the 'dirty' crafts such as the tanners and potters which were located separate from residential areas, often outside the city walls. These districts were not necessarily residential, as with the *mahalla*, however. Similarly, there is also the urban division of *rub'*, which translates precisely into 'quarter.' These were essentially administrative boroughs (or "wards" according to Wheatley, 2001, 514) of a city, such as in early Kufa and, again, at Samarra (Northedge 2008).

4.3.1 Inherited cities vs. created cities

In scholarly discussions of the history of Islamic urbanism, it is universally understood that cities can be placed into two separate groups based on the nature of their origin: those that existed before the Arab Islamic expansion and conquest and were thereafter incorporated into it (inherited or transformed cities), and those that arose without a substantial previous settlement due to and after the Arab Islamic expansion.[28] The latter category generally refers to urban settlements that emerged between the 7th and 15th centuries and can be further divided into founded cities – those that had a high degree of state sponsorship and planning – and spontaneous cities – those that developed organically out of circumstance (Almansouri 1991). Unsurprisingly, there can be a great deal of fluidity between these categories when practically applied to particular cases. This is both due to the ambiguity of the origin of particular cases and how the categories are defined/used. For example, while the early cities of Kufa and Basra are commonly accepted as having been founded (Denoix 2008; Kennedy 2008) – in that they required caliphal approval and exhibited formal, planned architecture/structure – Almansouri (1991) uses a stricter categorisation scheme and identifies these cities as spontaneously created, as opposed to other caliphal sponsored settlements that were envisioned, or pre-planned in his terminology, such as Baghdad.

Whether considered spontaneous or pre-planned, cities created during the Umayyad and Abbasid Caliphates (7th-10th centuries) exhibited a high degree

28 It is interesting to note that, at least to the author's knowledge, such a distinction is not made so acutely in the scholarship on the urban traditions of other pre-modern empires, such as with the ancient Roman world.

of formal planning, although the urban characteristics and incentives differed between the two dynastic states. During these periods, founding a city and the construction of a *jami* required approval from the caliph. Umayyad cities generally fall into two categories: garrison cities, or *amsar* (sing. *misr*) in the original sense of the word; and palatial cities, variously referred to as *qasr* or *madinat* (Milwright 2010).

4.4 Urban elements

This section is intended to give a summary of the features and structures that comprise a 'traditional' Islamic or 'Arab' pre-industrial urban setting. The list is not intended to be exhaustive, but should be representative of the significant urban elements that could be observed within pre-modern 'Islamic/Arab cities'. However, this is not to imply that every element is present or clearly identifiable within every instance/city examined, nor that the character of the elements is temporally and regionally homogeneous.

The topics in relation to the urban elements that will be covered include their (intended) functions, use, and the accommodated human activity associated with them. The physical architectural form will naturally be discussed, but with an emphasis on how the elements are manifested in archaeological contexts, particularly as seen on the ground – that is, in plan.

4.4.1 *Masjid jami*: The Friday mosque

Much as with a church/cathedral or, even more so, the basilicas in Europe, the *masjid jami* (often simply referred to as *jami*), known as the 'congregational' or 'Friday mosque' in English, is the 'heart' of the Islamic city, meaning that it was usually centrally located. As the name suggests, it is the mosque where all Muslim males of age within an urban settlement are expected to pray at midday every Friday. It was of such communal importance in the early times of Islam that it was often the first permanent building constructed in a new urban settlement (Wolper 2014). While the primary purpose of the *jami* has always been religious, its function was broader in scope in the first few centuries of Islam, and had secular uses. It also operated as a social and political centre for a city. Denizens of the city would frequent the *jami* for recreation and Quranic study. In the Umayyad and Early Abbasid periods, the *jami* was physically and functionally associated with civic and political institutions; it was the seat of the *qadi* (judge), the *Dar al-Imara* was often located very nearby, and from the Late Abbasid period onward, the major *madrasa* (Quranic school) was often located there (Bianca 2000). Although *jamis* were often grand in size and decoration, it was these secular functions and associations that truly distinguished them from neighbourhood *masjids* (mosques) that were intended for everyday prayer (Hillenbrand 1994). Additionally, the construction of *jamis* was government/state sponsored and, as such, required the permission from the caliph to the local governor to be built. The *jami* was such an important criterion for 'urbaness/citiness' that many communities in smaller settlements sought permission to construct one in order to raise their city status (Wheatley 2001).

Turning to architecture, the *jami* has a number of clear identifiable features that have changed little over most of the history of Islam.[29] Since prayer in Islam is

29 Apart from the courtyard – which also might be present – these features are required of local mosques as well, the only difference being in scale.

invariably oriented toward Mecca (*qibla*), it is required that every *jami* is oriented in this direction. To mark the orientation of prayer, a *mihrab* in the form of a niche is located in the centre of the *qibla* wall. In some cities, such care was given in the planning and construction of the *jami* orientation that the urban fabric and street system was disregarded, creating a conspicuous discontinuity in the urban plan. This might be a tempting characteristic to look for when attempting to identify a *jami*. However, exactness for the *qibla* was not universally sought, especially in *jamis* constructed during the Early Islamic period. The difficulty and expertise required in obtaining this precision resulted in approximations with some *jamis* facing in a cardinal direction. In fact, Islamic law permits that the *qibla* wall orientation be anywhere in the field of vision laterally (King 1995). Therefore, although the presence of this characteristic (orientation toward the *qibla*) would support the identification of a structure as a *jami*, the lack of it would not exclude its identification as such. The specific orientation of mosques, presumably including *jamis*, could even vary depending on the theological schools they were associated with. In Central Asia, the Hanfis, for example, who had their own mosque at Merv (Kennedy 1999), favoured a westerly qibla orientation (Golombek 1983).

Another major feature of the *jami* is the large central courtyard, commonly surrounded by arcade or hypostyle halls on three sides and a covered/roofed area on the qibla side. Although this feature is not required or universal of *jamis*, it is overwhelmingly common among them and the relatively few exceptions are often re-purposed structures such as churches, synagogues, and temples (Hillenbrand 1994). The exception to this is are the Turkish style mosques which developed to emphasise the dome and so became enclosed (Hillenbrand 1985).

The feature that is arguably the most frequently associated with the *masjid*, and mosques in general, is the *minaret*, most commonly called *manara* in Arabic.[30] Serving as the platform for the call to prayer, this feature is indispensable for the *jami* presently, but does not seem to have been a feature for the prophet's house/*masjid* nor for some early period mosques (Bianca 2000). Towers are present in some mosques before the 9th century (Wheatley 2001), although the architectural difference between them may be seen as superficial. As an architectural feature specifically for the call to prayer, it has been claimed that minarets are only present since the 9th century and are only consistent since the 11th century, with the call to prayer performed from rooftops before this period (Hillenbrand 1994).

Naturally, minarets are architecturally diverse across regions and time – varying from an orthogonal shaped belfry type in the Western Mediterranean to round spire-like minarets found in Afghanistan. Additionally, they may be incorporated into to the *masjid's* structure, abut it, or be completely separate – although adjacent to it as its own structure. Of particular note are the Abbasid spiral minarets found in Samarra, Iraq. However, neither cylindrical – a common style in Central Aisa – nor composite minarets have been found before the 11th century (Wheatley 2001).

Like the minaret, the architectural form of the entire *jami* varied over time and geographical area. In generalising the architectural forms of mosques, they can be categorised into four types: the Arab style, the Persian style, the Indian style, and the Turkish style (N. Hakim 2008). For the purposes here, only the Arab and Persian styles are of concern. Partially influenced by Classical design, Arab mosques are typified by hypostyle halls surrounding an open courtyard on four

30 'Minaret' came to English via the French rendition of *manara*. Other terms for this feature in Arabic are *samua'a* and *mi'dhana*.

sides, which, in their very early expressions, could be open on all sides except for the *qibla* wall. A deep gallery is commonly found on the *qibla* side, allowing for inside prayer, and is often topped with domes. This style is characteristic of the Umayyad and Abbasid Caliphates, with the early mosque at Kufa exemplifying the former, and the colossal Al-Mutawakkil and Abu Dulaf mosques at Samarra the latter. This style was common in all regions for the first four centuries of Islam. The next prominent style, the Persian, arose in the 12th century. What distinguishes this style are the four *iwans* (a vaulted hall open on one side) located in the middle of each wall of the mosque which surrounds a central courtyard, and hence the alternate name for this configuration, the 'four-iwan style'. Popularised by the Seljuks, the four-iwan style mosque became common in all the Persian influenced Turkic eastern Islamic lands (with variation) such as in Mesopotamia, Anatolia, Central Asia, and remained so in Persia (Hillenbrand 1985).

4.4.2 *Dar al-Imara*

From the Umayyad period into the Early Abbasid period, the *Dar al-imara* was an important component of the city core. As the 'House of Government', it held the administrative offices and occasionally was also the residence of leading government officials of the city. As such, it may be considered a kind of 'palace', although functionally broader in that it was associated primarily with administration rather than simply residence. While the *Dar al-imara* could be subsumed into the category of palaces, to be discussed in the next section, its temporal and architectural conspicuousness in Early Islamic cities warrants its own category.

During early periods, the *Dar al-Imara* formed a 'complex' or 'ensemble' together with the *jami*. In historiographic sources, the buildings are said to be 'back to back', with the *Dar al-Imara* on the *qibla* side of the *jami*, although this does not necessarily mean that they were physically joined or abutted.[31] Cities in which there is historiographic reference to this ensemble include Kufa, Basra, Damascus, Baghdad, and Merv. Kufa is often alleged to have been the origin of this ensemble (Santi 2019), and to the author, it is one of the only known partially surviving examples, as the *Dar al-Imara* is in ruins.[32] In addition to the close association with the *jami*, it was also not uncommon for a bathhouse to be in close proximity to the *jami* and/or *Dar al-Imara* for sacred ablution before prayer. In newly founded cities, a large open space or square was also often left around the complex to buffer it from the rest of the city. The physical arrangement of the structures in cities in which the ensemble is said to have existed normally assumes that the *Dar al-Imara* was placed on the *qibla* side of the *jami*, but this is not always made explicit in historiographic accounts, such as the case with the round city of Baghdad. The original reasons for the combination was supposedly to provide more security to the treasury after being robbed in Kufa,[33] while the reason for the particular arrangement is presumed to have given the governor (or Khalif in the case of Baghdad) direct access from his residence to the *maqsurah* (private space for a ruler near the *mihrab*) through an adjoining door (Creswell and Allan 1989).

31 In the case of Kufa, the structures were initially separated by a small lane, but were later joined in a second phase of construction (Santi 2019).

32 The other possible example is Umayyad 'Anjar (Necipoğlu 1993), but as the settlement itself was a 'palatial city', it is unclear to the author if the palace then had a comparable function to the *Dar al-Imara*, and was referred to as such. An additional mark against this designation is that the mosque and palace did exhibit the particular *Dar al-Imara/jami* ensemble orientation.

33 Originally, the *bayt al-mal* (royal treasury) would have also been attached (Bianca 2000; Wheatley 2001).

However, Wheatley (2001) points out that the reasons given by the 'Islamic chroniclers' do not explain the particular arrangement of the structures – *Dar al-Imara* on the *qibla* side of the *jami* – and so are not particularly compelling. As he explains, the protection of the treasury could have been possible on any of the three sides of the *jami*, as well as with the governor's access to the *maqsura* if some partition was in place. As a speculative alternative explanation, Wheatley suggests that the arrangement may have symbolically reaffirmed the governor and his decisions by passing the prayers of the community through his residence. While the specific arrangement of the *Dar al-Imara* with the *jami* is somewhat elusive, its centrality and association with the *jami* is more readily apparent. Caliphs in Umayyad and Early Abbasid periods performed dual roles of head of state and religious leader. Indeed, they would have often led prayers and received audiences in both the *jami* and their palace.[34] Furthermore, the Umayyad and Early Abbasid Caliphates were the sole states controlling the Muslim world in their time, in contrast with later periods of concurrent competing caliphates and sultanates, and accordingly a degree of symbolic hegemony may be inferred from the spatial arrangement (Necipoğlu 1993).

From the few historiographic accounts and one archaeological example, it cannot be ascertained with certainty if there was an architectural standard layout followed for the *Dar al-Imara*, although there do seem to be common architectural elements and Wheatley (2001) gathers that they were generally axial. The original plan at Kufa is roughly square in shape, with later phases having added a series of rooms around the inside of the outer perimeter and a building complex in the middle with an off-set central courtyard (Fig. 12; Santi 2019).

In *Masalik al-Mamalik*, al-Istakhri provides a description of the *Dar al-Imara* of Abu Muslim at Merv, from which Creswell (1989, 161) constructs a plan (Fig. 13) and the following translation of the passage:[35]

> *"Among the buildings of Abū Muslim is the Dār al-Imāra, and it is at the back (zahr) of the mosque. And in this dār is a domed chamber…in which he used to sit. It is a domed chamber made of burnt brick and its measurement (sa'a) is 55 cubits.*[36] *There is access to the flat part of the roof from the interior. And the domed chamber has four doors, each leading to an īwān, and the height of each īwān is…(blank). And in front of each īwān is a square sahn."*

Like the *Dar al-Imara* at Kufa, the one at Merv is also square in plan. Additionally, Creswell suggests that the *Dar al-Imara* of Abu Muslim closely resembled the palace of al-Mansur at Baghdad, and the palaces named Jausaq al-Khaqani and Balkuwara at Samarra.

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34 As described above, the *Dar al-Imara* was the seat/palace of regional governors as well as the caliph, and although Necipoğlu (1993) does not explicitly describe this situation among governors, it is reasonable to assume an extension of these roles from caliph to deputy.

35 Hugh Kennedy provides a translation of Istakhri's entire description of Merv, and in which the passage that Creswell cites is found, but it differs slightly in translation, some of which Kennedy himself points out. Although the differences are seemingly only minor technical ones, they could matter in the interpretation of the arrangement of structures in Merv's civic core, if Istakhri's description is taken at face value. The following are the notable and presently relevant differences, with Creswell's translation followed by Kennedy's: "…the Dār al-Imāra, and it is at the back (*zahr*) of the mosque.", "The Government House was back to back with the mosque." Still speaking of the *Dar al-Imara*, "There is access to the flat part of the roof from the interior.", "You enter it from within the supports of the roof."

36 Around 33 m, according to Hugh Kennedy (Herrmann 1999, 122).

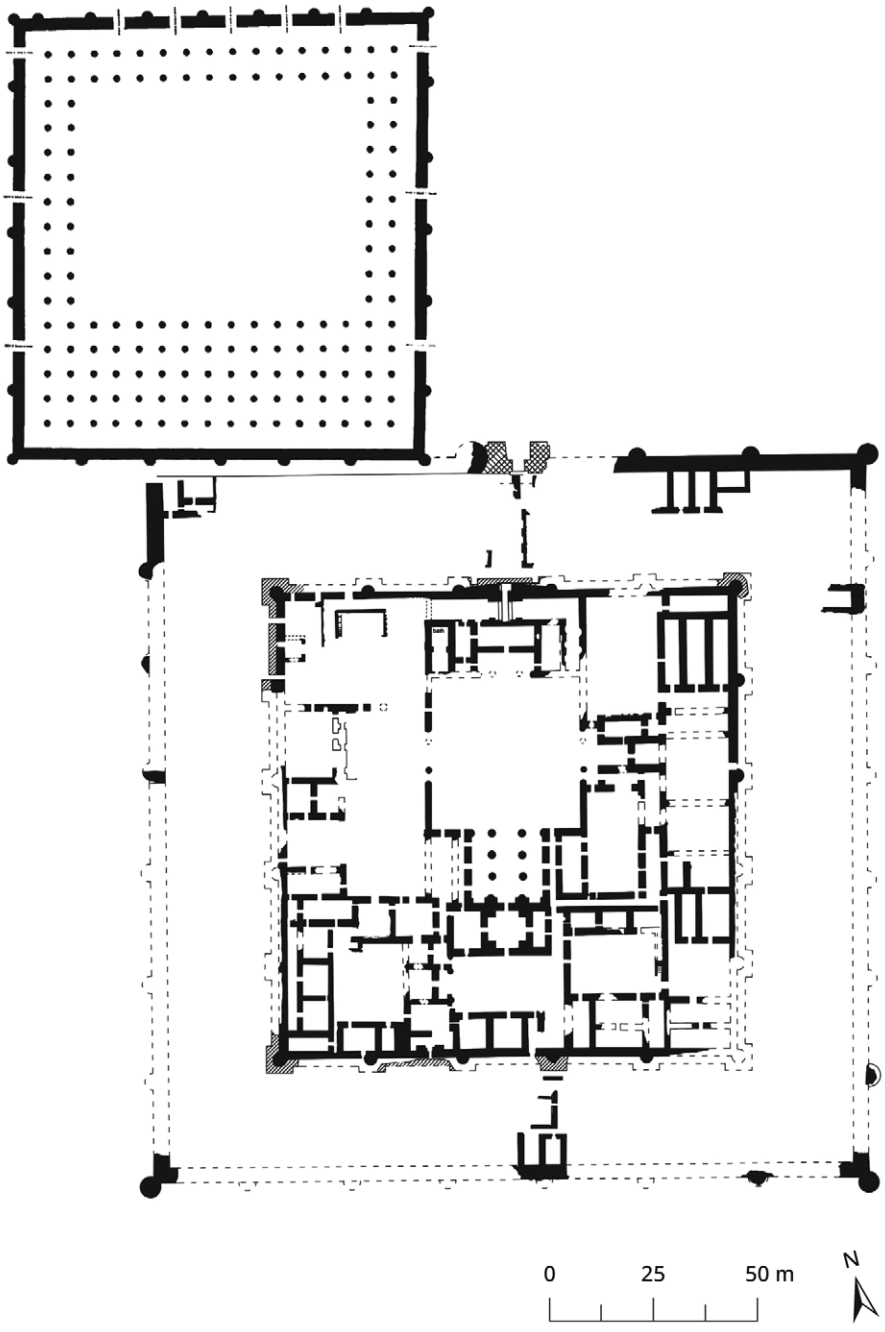


Figure 12. The congregational mosque (upper left) and *Dar al-Imara* complex at Kufa (after Santi 2019, 77).

Other common architectural elements shared among the *Dar al-Imaras* were the two story height/second story audience chamber and the *qubbat al-khadra'* (usually translated as 'green dome' but alternatively as 'dome of heaven'; Bloom 1993).[37] Regardless of the colour of the *qubbat al-khadra,* it indicates together with the second story audience chamber and historigraphic sources that there was significant vertical prominence to most *Dar al-Imaras,* likely as an imposing symbol of imperial power and centrality. *Qubbat al-khadras* were reportedly present

37 The green dome is another feature that is hypothesised by Hillenbrand (2012) to have either originated with Merv's Abu Muslim Mausoleum or it was the origin of significant influence for the construction of others throughout the Islamic world.

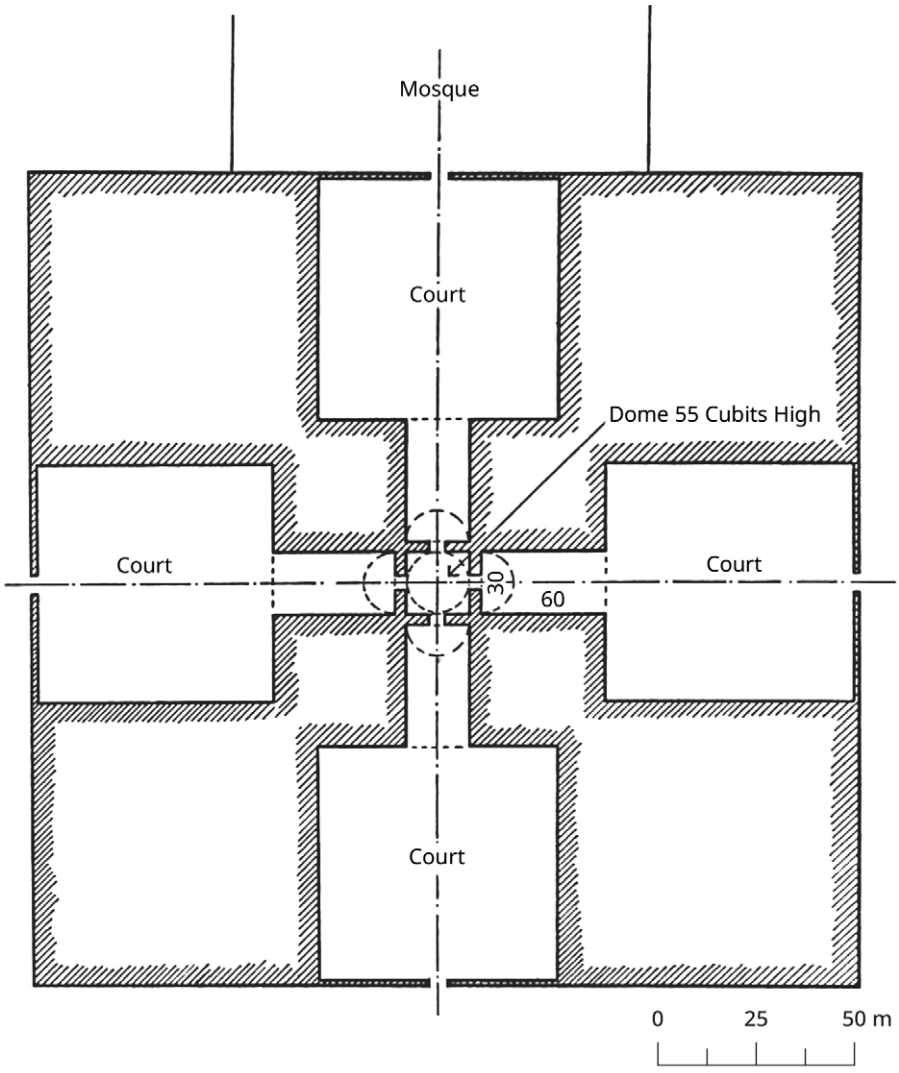


Figure 13. Proposed plan of the *Dar al-Imara* at Sultan Kala (after Creswell and Allan 1989, 162).

on the *Dar al-Imaras* and palaces in Damascus, Rusafa, Kufa, Wasit, Hashimiyya, and Baghdad (Necipoğlu 1993).

The third paradigm specified by Necipoğlu (1993) covers the period of the mid-11th century to the mid-13th century when there was heavy influence from the dominant Islamised Turco-Persian polities, such as the Great Seljuk Empire.

4.4.3 *Kasbahs* and palaces

This section will cover other forms of palatial architecture located within urban fabrics[38] from around the mid-10th century to the mid-13th century. Palatial structures were architecturally diverse throughout the Islamic realm and over time, thus no standard conceptual form can be described, yet there are certain patterns of architectural elements with spatial association that can be observed.

The rise of the Abbasid Caliphate advanced the influence of Persian culture throughout the Islamic world at the time, as is readily seen in architecture through features like the vaulted *iwan*, which was a common feature in Abbasid *Dar al-Im-*

38 This is to contrast with other palatial architecture located in the countryside or hinterland, some of which were considered urban (in that they were referred to as *madinas*).

aras and palaces. While Persian influence remained, the first half of the 9th century marks a change in the characteristic of Abbasid palatial architecture, what Necipoğlu (1993) outlines as the second paradigm in medieval Islamic palatial architecture (the first being the *Dar al-Imara/jami* complexes). Vertical prominence lost emphasis and was replaced by expansive palatial compounds accompanied by garden pavilions and open courtyards with vaulted *iwans*. Horizontal monumental architecture supplanted the vertical as a way to convey the caliph's/governor's splendour and eminence, and high external walls for privacy. Accompanying the change in architecture was also a change in spatial relationships with palaces; palatial residences were no longer in close proximity to the *jami*, as they often had their own private mosque, and were located in the suburbs away from the busy central urban areas or even outside the city entirely. While there may have been some practical reason for the spatial shift of the palace, in that more open space was required for more horizontally expansive complexes, the shift likely also reflected the diminishing religious role/duty of the caliph and his constituent governors and, therefore, close proximity to the *jami* was not required (Bloom 1993).

4.4.4 *Madrasas*

Madrasas were institutions of higher learning of Islamic law in primarily Sunni custom, and can be approximately translated to 'college', but the term has come to signify more simply 'school' in modern Arabic (Leiser 1986). Originating in Khurusan in the early 11th century CE[39] for the purpose of bolstering Sunni Islam, they quickly spread west throughout the Islamic realm and became a significant educational institution within cities. While law was also taught formally in the mosques, the *madrasa* was built solely for this purpose and so provided accommodations and financial support for a professor and students. Despite their role as academic institutions, *madrasas* could also have a significant influence within an urban system. In the late 12th century, the Salahiyya Madrasa in Cairo was essentially described as a separate town, even with a bath and shops (Leiser 1986).

In terms of architecture, the *madrasa* conformed to other public structures from the Seljuk period (11th-12th centuries) onward – especially in areas of Persian influence – including the four *iwan* plan: a quadrate structure with a large central courtyard surrounded by cellular rooms, and four *iwans* situated on the axes of the sides. In later medieval periods, major *madrasas* had come to be incorporated into building complexes with other public structures (Wolper 2014). Unsurprisingly, as a part of the complex, a mosque would be associated with a *madrasa*, but also baths, tombs/mausoleums, and other *madrasas* could make up a complex.[40] Unfortunately, there are only three surviving examples of pre-Mongol invasion *madrasas* in Greater Iran. The identity of only one is certain (Hillenbrand 1985).

4.4.5 *Caravanserais*

Caravanserai is a term of Persian origin that pertains to an inn, primarily to aid travelling merchants. It is a collective term used in scholarly contexts for structures with similar functions referred to in regional parlances, for example, as *funduq* (mainly used in the Maghreb) and *khan* (also of Persian origin but used in Turkic

39 Indeed, Kennedy (2006) even suggests that *madrasas* originated in Merv.

40 The Po-i-Kalyan and Lab-i Hauz complexes in Bukhara are good extant examples of the madrasa complexes.

speaking regions) (Petersen 1999). They were common not only along well-travelled trade routes between settlements, but were also found within the fabric of cities and villages. Although associated with the Islamic periods, caravanserais were known in antiquity, and the form discussed below likely had an origin in late antique Persia. Architecturally, caravanserais closely resemble other large early period public structures, such as *madrasas* and *jamis*; they are generally square in plan with a large central courtyard bordered by cellular rooms. In Central Asia, the four-iwan scheme and axis-oriented entrances/gateways were also common among caravanserais, just as with other public architecture (Mirzaakhmedov 2016). However, in contrast to urban public architecture, caravanserais were also defensive in function and their architecture reflected that in the form of crenelations and corner towers. Although this standard architectural form could occur within a city – most notably when city-adjacent caravanserias were subsumed in the expanding urban fabric – inter-mural examples could differ in design, notably in size but also in arrangement. As such, the architectural form of the inter-mural caravanserais is less fixed than that of their rural counterparts.

Irrespective of their architectural form and location, caravanserais functioned nearly the same. All provided lodging and provisions for merchants and their pack animals, but in addition to operating as wayside inns, they could also host markets, places of prayer, and workshops. In terms of how they function, substantial caravanserais have even been described as cities scaled down. Within cities, they were also the venue for the exchange of goods and currency for wholesale and retail through the city as well as further along the trade routes. Thus, they also functioned in part as another type of *suq*, or market (Taheri 1980).

4.4.6 Public baths and bathing

Bathing is integral to Islamic society, and ritualistic bathing is considered necessary to purify the body for certain religiously associated acts. There are two manners of ablution: minor, referred to as *wudu*, in which parts of the body are washed before prayer; and major, called *ghusl* which involves washing the entire body with running water and is performed before *wudu*, after sexual intercourse or menstruation (Sibley and Jackson 2012).

Throughout most regions and history of the Islamic world, most houses were not equipped with running water, and so bathing (especially *ghusl*) required public facilities. The term *hammam* in most contexts connotes a public bathing facility for *ghusl*, and their tradition and architecture have firm roots in the small Roman *balnea* bathing facilities (Sibley and Jackson 2012; Thome 2005). As mentioned above, *hammams* have been considered a necessary criterion for the urban status of a settlement since the Umayyad period, and even the importance of a settlement seems to have paralleled the number of bath houses present, emphasising the important role that bathing has had in Islamic society. Though ubiquitous throughout the urban fabric of cities, there are a number of spatial relationships associated with *hammams*. Due to the requirement to bathe before prayer, close proximity to mosques is a natural location for *hammams*, but they may also be spatially associated with other institutions that accommodate prayer, such as *madrasas*, or that involve some level of uncleanliness, as in *caravanserais* (Sibley and Jackson 2012). There is some suggestive evidence that the spatial associations were different early on in the time of Islamic expansion. In the newly founded quadratic cities of the Umayyads, such as in Anjar and Ayla, the *hammams* seem to be placed just inside the main (usually north) gate of the city, on the east side of the

main street leading to the *Dar al-Imara*. This has been interpreted by Thome (2005) to signify that those intending an audience with the governor would first bathe. Apart from ritualistic ablution, *hammams* also partly performed an unofficial social function, similar to, but to a lesser extent as did Roman baths.[41] As *hammams* were for the use of both men and women (that is, during prescribed times), it was one of the few places that women could socialise (Thome 2005).

The architecture of *hammams* varies considerably, but they do exhibit a shared syntax and have one element that notably distinguishes it from other structures; the lack of a central courtyard. Invariably *hammams* can be partitioned into three sections: entrance and undressing area, bathing spaces, and an area for the furnace (Sibley and Jackson 2012). The bathing areas were further divided into sections which roughly correlate with the baths of late antiquity: the *frigidarium*, *trepidarium*, and *caldarium*. In many cases, the primary bathing rooms were domed, had a fountain or small pool in the centre, and included niches incised into the walls in order to provide more privacy for individual bathing (Sibley and Jackson 2012). With only few exceptions, the layouts of late medieval *hammams* are mostly linear, meaning the different rooms lead to one another (Sibley and Jackson 2012).[42]

Unless partially exposed or exhibiting particularly defined soil marks, the complex and variable architecture of *hammams* means that their archaeological remains could prove to be difficult to identify on the surface. Without excavation, the features that would possibly be conspicuous enough on the surface in aiding identification might be the series of niches in the walls of some rooms, benches lining some walls, the hypocaust style heating, and the pool/fountain (which could resemble and be confused with a small courtyard/light well), if any of these features are even present. However, it is reasonable to assume that *hammams* should indeed display more detailed reliefs or, at least, better preservation in contrast with other architecture constructed with mud brick, since the use of fired brick is common in the construction of *hammams* (Kheirabadi 2000) as a protective method against moisture and which preserve better than simple sun-dried earth.

Naturally, spatial association with other features (if identified) might also aid in the identification of *hammams*. An obvious place to find *hammams* is in close proximity to a source of water, such as a *qanat* or reservoir.

In order to fulfill *wudu*, facilities called *mida'at* are used. Often these are simply shallow pools of water – which is reflective of their common name in Iran, *hawd* – which may have steps leading down on some or all sides. *Mida'at* are often located near the entrances of major mosques, but can also be found in other public facilities such as madrasas (N. Hakim 2008). As unexcavated archaeological remains, one would expect *mida'at* to appear similar to courtyards – as a depression, often vegetated – however without significant encompassing architecture.

4.4.7 City walls and gates

While not present in all historic Islamic cities, the walls/ramparts (*sur*) and gates (*bab*) are together a conspicuous element of many 'traditional' Islamic cities. In many cases, the *sur* surrounds the original *medina*/'old city' with the later urban

41 In their survey of the spatial layout of historic *hammams* in the Mediterranean, Sibley and Jackson (2012) determine that the undressing room is usually the largest by area, which they interpret as reflecting its importance and social function.

42 Umayyad *hammams* appear to be mostly linear as well, although this is merely an observation of the author.

developments beyond, but it is also not uncommon for cities to have an inner wall and an outer one that encloses the newer districts (B. S. Hakim 2008). As noted above, the *sur* were just as significant as a symbol of urban status as they were for defence – if not more so – depending on the period and region. However, many early cities in the Islamic world were largely not walled until the 11th century (Herrmann 1997). Architecturally, the city walls vary considerably between cities and regions (even though B. S. Hakim [2008] claims that they are on average 6 m high and 2 m wide), but are ordinarily dotted with defensive or symbolic towers (*burj*).

As with any city with walls, the gates of Islamic cities are ordinarily placed on the major thoroughfares/arteries. But just as with ancient cities in the Near East and, to some extent, with medieval European cities, the city gates did not function simply as regulated access points into and out of a city. Rather, city gates were nodes of traffic and as a result often also served as places for markets, where areas were left open just inside the gates to form 'market squares'. The city gates are still the place where bulk merchandise is loaded, unloaded, and distributed throughout the city and because of this, ample space is provided so as to not cause congestion (Bianca 1999).

4.4.8 *Rabads* and *mahallas*: Partitions of the city

The term *rabad* most often refers to the later urban developments that expanded beyond the original, 'old city', core. It is often translated simply to 'suburbs,' but this can be a bit misleading considering its other uses.[43] The term may also be used for any areas just outside a city, or for the residential areas that other kinds of urban settlement, such as a fort/*kasbah*/*qasr*, may have (B. S. Hakim 2008). Since their growth is 'organic' rather than planned, they do not have any strict standard form or topography, but it can be observed that they are generally located outside the city gates and along/around the roads leading into the city.

Mahallas are another category of subdivision of the city, and is most accurately translated to 'quarters', or 'neighbourhoods'. Even though cities of any culture or period can be said to have 'quarters,' meaning places that are distinguishable in some way, the character of the residential *mahallas* arguably make them one of the most distinctive features of Islamic urbanism. *Mahallas* emphasised the separation of people who share a common ethnic, cultural, or tribal affinity, to the extent that, in some cases, they are walled and/or gated. Writing in the 10th century CE/4th century AH, Istakhri mentions the quarters of Merv twice, emphasising that they had "well-known boundaries" and further that the city was "superior in the cities of Khurusan" in part for the "divisions of its buildings and quarters" (translation by Kennedy 2001, 123). This is taken by Wheatley (2001, 310) to signify that the quarters had walls and gates.

43 As Wheatley (2001) notes, the use of suburb(an) in pre-industrial cities should be understood closer to its original, literal sense of 'under/below the walls', not according to modern standards denoting a distant tributary commuter settlement.

4.5 Circulation spaces

4.5.1 The circulation system: Streets, alleys, routes, paths

A trait that has been often cited when discussing traditional Islamic – and especially Arab – cities is the labyrinthine nature of their narrow streets and alleys. Like the concept of the Islamic city as a whole, this characterisation of the street system has received a fair amount of deserved sceptical scrutiny, as in the past, this characteristic attribution has carried negative connotations of disorder with it, but has persisted as a feature of reference (Falahat 2013). Some of the characterisations of Islamic city streets are not entirely unfounded, but are oversimplified.

Generally speaking, from the scholarly sourced viewpoint, the quintessential street system in an Islamic city consists of three types of lanes: major thoroughfares, streets connecting the latter, and cul-de-sacs (Nooraddin 1998).[44] Thoroughfares and connectors are public spaces, and both can be the location of major and minor markets (*suqs*), which may be covered for protection from the elements. However, thoroughfares frequently connect city gates and civic venues, such as the *maidan*, a large public 'square' commonly situated adjacent to the citadel when present. The public nature of these streets required specific provisions for their use and maintenance. According to Arab-Islamic concepts of *fina'* (space) and *fiqh* (jurisprudence), thoroughfares were required to be a minimum of 7 cubits in width – roughly 3.5 meters, enough for pack animals to pass each other – and void of obstructions. In contrast, cul-de-sacs are considered private, as they lead to 'housing clusters' which are often occupied by extended families (B. S. Hakim 2008). However, it should not be expected that these stereotypical characteristics and prescriptions have always been strict realities.

These characterisations of the street pattern disregard temporal and geographical variations in traditional Islamic lands. For instance, the Umayyads favoured classically influenced, wide, connected, and rectilinear streets when founding urban military encampments, much in contrast with the stereotyped narrow and winding passageways. Additionally, the labyrinthine nature of cities located in Islamic lands likely does not have its origin in the religion itself, as it has been shown that the process of degradation of the rectilinear street system of Damascus began in late antiquity (Kennedy 1985). The winding quality of the streets also does not hold universally true. Arising from their agricultural origins, street systems in cities of the historic Iranian sphere of influence are fairly rectilinear, due to following the water channels that irrigated former fields (Bonine 1979; Kheirabadi 2000).

However warranted, the criticisms of the concept of stereotypical street systems in Islamic cities does mean to imply that there is not something about them that is singularly characteristic, as anyone who has spent time in an 'old quarter' of an historic Islamic city can attest. That the streets are often characterised as 'labyrinthine' is not very distinguishing, as this could be applied to many European medieval cities. The distinguishing quality of the street system may in part be due to the relative profusion of cul-de-sacs, indeed, it has been calculated that in Ottoman Cairo and Aleppo, 50 percent of the streets are dead ends (Kosstof 1999, 106) – that lends them an archetypal tree-like tributary system structure (Marshall 2005).

44 In contrast, in the traditional Arab-Islamic perception, lanes are classed into two categories: through streets (*tarik al muslimeen*), which are public, and dead-end alleys (*zuqaq*) which are co-owned by residents and private (B. S. Hakim 2008).

4.5.2 Markets: *Suqs* and *bazaars*

Suq is the term used for market in Arabic speaking regions, while *bazaar* is used in the Turkic and Persian dominant regions. *Suqs/bazaars* are markets dealing with small bulk goods for consumers (*i.e.* retail) and could be located virtually anywhere in a city (Wheatley 2001). As a result, they exhibited a range of different morphologies. *Suqs* could simply be public places where vendors displayed their merchandise on the ground, as early, 'unofficial', and temporary *suqs* often were. However, more formal *suqs* are generally manifested as linear arrangements of temporary stalls with merchants and/or vendors, and shop/stall-lined streets that often fronted workshops. Historiographic references to *suqs* in the first few centuries of Islam are rare, and so their morphology and role in medieval Islamic urban life are often inspired by more recent examples. Wheatley (2001, 239) cautions against projecting the form and function of contemporary or recent *suqs* to medieval ones, but he concludes that the *suq*

> *"was simultaneously a specialized type of economic organization, a subculture within the larger entity of urbanized society, and a morphological feature of the urban landscape."*

Therefore, the following outline will draw on what is known about *suqs* regardless of period, unless specified.

Although found throughout a city, many *suqs* were specialised yet interconnected, particularly in the city centre (Bianca 1999). From their locations and different services provided, a somewhat hierarchical typology of *suqs* can be formulated, as B. S. Hakim (2008) explains based on Tunis. Although modelled mostly on one city, this typology can be generalised to accommodate most other examples, if with some elucidation:

1. The central *suq* area surrounding or in the vicinity of the *jami*

This area is often comprised of several specialised interconnected *suqs* which commonly sell "precious" goods. In these extensive markets, stalls/units commonly abut each other forming parallel, shop-lined lanes.

2. Linear *suqs*

These markets line the main thoroughfares that connect the main gates of the city. These tend to be retailers of more common, everyday goods. In cities that exhibit an axial arrangement, the *suqs* can then assume a "cruciform distribution," called a *musallabah* (Wheatley 2001, 247).

3. *Suqs* adjacent to city gates

As mentioned above, *suqs* could also occur on both sides of the city gates (*babs*). These markets may also be considered continuations of the linear type (B. S. Hakim 2008).

4. Periodic markets

This category includes markets that could occur weekly or seasonally, sometimes to mark special occasions. In the past, these were associated more with villages and smaller settlements, but naturally occurred in cities as well. Any large open free space – such as the area near the city gates or the squares – could be used for these markets, and since they were occasional, they were conducted with temporary market stalls.

5. Local *suqs*

Markets that served local communities within the city are called *suwayqas*, which means 'little suq' (Wheatley 2001). These tended to sell everyday needed goods, such as food, to the locals. They can be scattered throughout the city, but often occur at street junctions or locations that functioned as the 'neighbourhood centre' (B. S. Hakim 2008).

However, historiographic descriptions of *suqs*, unsurprisingly, do not follow this analytical categorisation, with the possible exception of periodic markets. Rather, *suqs* tended to be described by what was primarily sold. Such was the case with the Mirbad in Umayyad Basrah, a collection of different *suqs*; here one could find markets of apothecaries (*Suq al-Saydallanin*), leather goods (*Suq al-Dabbaghin*), and book related materials (*Suq al-Warraqin*) (Wheatley 2001).

Just as with topography, *suqs* also varied considerably in architecture and in form. Depending on the goods provided, *e.g.* with non-perishable goods, the market stalls could front the workshops of production, and living quarters could also be located on a second floor. Principal *suqs* were not infrequently covered in order to give some relief from the sun. But this feature would not necessarily pertain to the size of the *suq*, as smaller *suqs* in small settlements were also known to be covered (Wheatley 2001). Main *suqs*, such as the street-lined linear and central ones according to B. S. Hakim (2008), were also commonly gated and locked at night, so as to prevent theft.

Of course, *suqs* could also occur along the main roads leading to a city, usually clustered around *caravanserais* (Wheatley 2001). Given their mercantile purpose, it is not surprising that they were associated with *suqs*, and could be viewed themselves as a special type of *suq*.

4.6 Urban fabric and character

4.6.1 Residential areas

A common characteristic attributed to Islamic cities generally is the continuous and cellular appearance of the urban fabric. The explanation for the cellular characteristic has been often ascribed to cultural principals that govern the spatial relationships of residential units. The residential fabric of Islamic cities is described typically as dense and irregular, with most houses sharing walls. This is thought to be due to the minimal administrative municipal regulations of construction and maintenance at the local scale of the city, and instead leaving this sort of matter to the inhabitants themselves. The result is a particularly vernacular residential architecture composed of sequential architectural additions to houses. Accessible voids are filled – except for internal household courtyards and public through space – as more space is needed. Extensions spanning over streets and alleys to adjoin houses is not uncommon (Bianca 2000).

Another cultural principal that is thought to influence the form of the urban fabric is the emphasis on household privacy in Islamic society. Indeed, a regarded ideological trait of Islamic urbanism is the emphatic distinction between public and private space. Houses are oriented inwards, in that there are few – if any – external windows. Instead, light and air are instead provided by a central internal

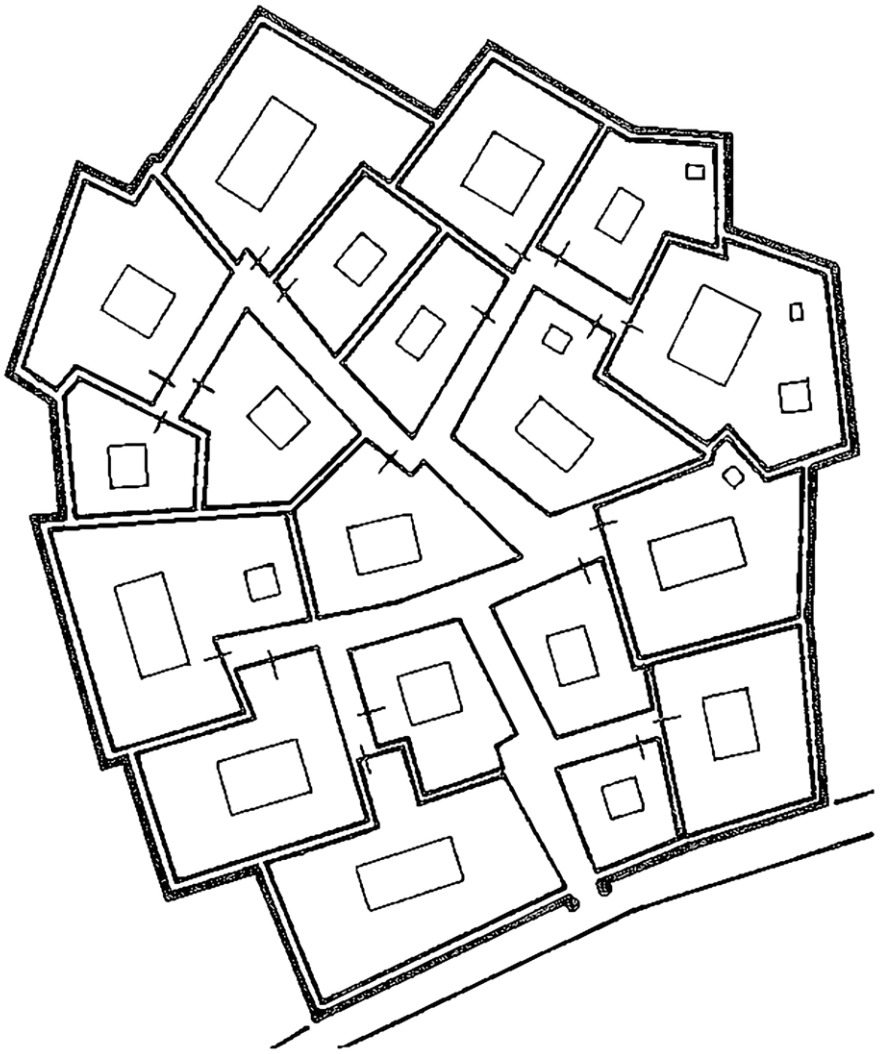


Figure 14. A plan of a typical housing cluster in Islamic cities (after Bianca 2000, 38).

courtyard.[45] Any external opening, such as doorways and any windows, are kept out of direct line of sight or are screened, such as with the *mashrabiya*.

The house is the most private in a series of incremental spaces that increase in intimacy from the public space. Rather than situated along through streets as is familiar with other western forms of urbanism, houses in Islamic cities are organised into 'clusters' situated around dead-end alleys and cul-de-sacs (Fig. 14). Housing clusters can be considered one degree removed from the house as the most private/intimate space. Occupants of housing clusters commonly share extended familial relationships between the households of the cluster, and this is considered to be the influencing factor in the arrangement of the clusters. The model of the housing cluster is idealised, however, and actual residential fabrics and social relations conform to this only in degrees. Accordingly, the manifestations of a housing cluster are nebulous and they can therefore be difficult to identify as separate entities.

45 As the reader likely noticed from the various urban elements discussed above, the configuration of a central courtyard with the lack of external windows is common among most kinds of structures, the only distinguishing characteristic being scale. This makes certain structures, such as mosques, caravanserais, madrasas, and even hospitals, nearly indistinguishable in plan.

4.6.2 Water distribution

Potable water provisioning and waste water disposal can have a significant impact on the character of Islamic cities to varying degrees depending on the traditional system. A means of supplying settlements with water common to most arid regions of the Islamic realm is the *qanat,* a water channel, most commonly underground. This method is known by different names in different regions – *kariz* in Iran, *falaj* in the Arabian Peninsula, and *foggara* in North Africa – but the principal is the same: a channel with a slight grade to aid flow diverts water from a source to a settlement. The source can be a river, but *qanats* are associated more with sourcing water from underground natural mountain wells. In the latter case, *qanat* tunnels can be especially deep, but their presence is detectable on the surface by maintenance shafts placed along a *qanat* at short intervals. A *qanat* usually surfaces just outside the settlement where branching channels carry the water to various facilities such as fountains, reservoirs, pools, and gardens – although in some cases, channels continue underground to provide houses with private wells (Bonine 1989).[46]

Waste water is usually disposed of using drainage channels in the streets. Alley channels flow into thoroughfare collector channels which eventually flow into a moat if the settlement is equipped with a city wall, a body of water, or a main sewage channel which itself will drain into one of the aforementioned.

4.7 Regional Islamic urbanism

4.7.1 Eastern Iranian cities

Seen as a branch of Islamic urbanism, Iranian cities are very similar in form and function to the "traditional Arab" cities. Likewise, since large portions of Central Asia, such as Khurasan and Transoxiana, were at times either directly or indirectly under the influence of ancient Persian empires, cities in these regions can be considered a subdivision of Iranian urbanism. However, as will be shortly demonstrated, the application of the Iranian urban model to Islamic Central Asian cities might be ill founded, as there are some significant differences in their form and development. Since the morphology, fabric, and urban elements of Islamic urbanism as a whole have already been discussed, the following section will only cover the topics where there is difference, or where certain aspects stand out.[47]

Akin to more western Arab-Islamic cities from the Middle Islamic periods onward, in form Iranian cities are bipartite; the *shahristan,* or inner city, in Iranian cities corresponding to the *madinah,* and the *quhandiz* corresponding to the *ark/arg* or *kasbah,* the walled citadel (Sobti 2002). If including the *rabads* (unwalled suburbs), this would correspond to *birun* in Iranian cities (Wheatley 2000). Topographically, the situation is similar, with the spatial relationship of the urban elements in Iranian cities like their more western counterparts. On a finer scale, the urban fabric also appears similar to that of the Arab-Islamic cities in that it is fairly dense, often with buildings abutting one another, and courtyards or 'light wells' in structures that are ubiquitous. Likewise, the circulation/street system has been likened to Arab-Islamic

46 The distribution of water to a settlement from *qanats* results in a very particular patterned urban fabric in regions under Persian influence, which will be covered more in detail in the next section.

47 See Kheirabadi (2000) for a thorough outline of Islamic period urbanism in Iran.

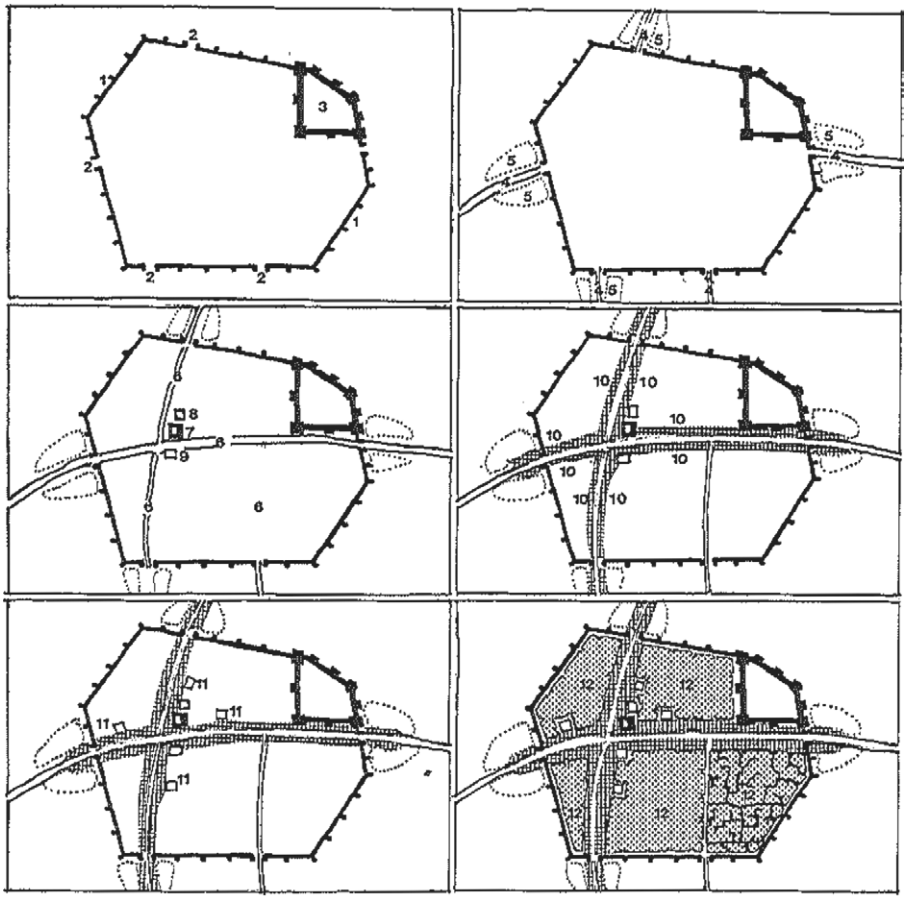


Figure 15. Schematic of a stereotypical Islamic city in Iran (after AlSayyad 1991, 31).

cities by Orientalist scholars as being organic and labyrinthine, with many cul-de-sacs (Bonine 1979), and indeed, dead ends appear ubiquitous in the Iranian urban fabric. Conversely, it has also been noted that traditional Iranian cities display regularity in that many streets run straight for considerable distances and often meet each other at right angles, which can produce the effect of cardinal orientation.[48] The street network and the source of its shape will be discussed in detail below. The comparative similarities are somewhat superficial, however, as the motivators that give rise to these similar physical forms are pragmatic, they are not necessarily culturally or religiously specific.[49]

4.7.1.1 Street network and water distribution

Different influential factors have been proposed for the observed semi-grid pattern of Iranian villages cities, such as environmental and cultural-religious influences. The arguments centred around religious influences present the streets as following

48 Bonine (1979, 201-211) is careful here and points out that the regular geometry of Iranian cities "lacks the rigid symmetry of such planned cities" of "the Indus, of ancient Greek and Rome, or of modern Western cities".

49 Moreover, the similarities between urbanism in the two cultural regions, via the Orientalist doctrine, is only tenable with Islamic urbanism from the Late Islamic/early modern period onward, particularly in reference to the similarities in urban fabric density.

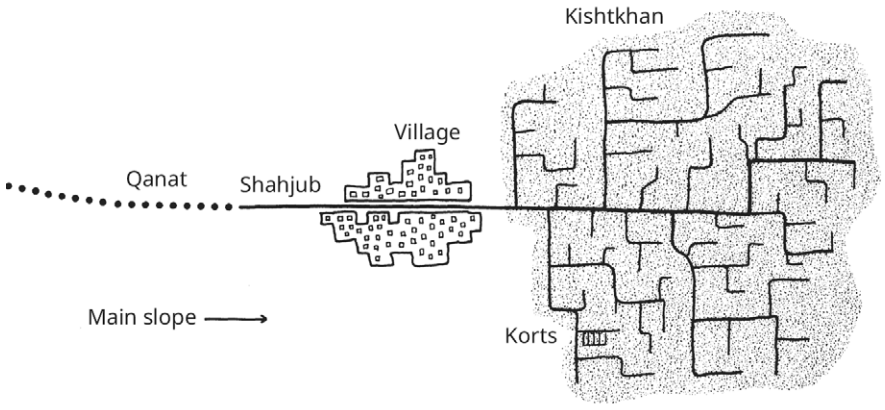


Figure 16. A schematic of a typical village and agricultural irrigation systems (after Bonine 1982, 154).

the alignment of structures that are oriented towards the *qibla* (Bonine 1979), but this argument is weak, in that urban systems in other cultural areas do not necessarily display similar orientations of street networks as might be expected if this were the case. Arguments for environmental influences make the case that narrow street and courtyard house orientation are for optimising the effects of wind and sun in a hot arid environment. While it would be surprising if environmental factors did not influence the form and orientation of domestic structures and streets in some way, if it was the prevailing influencing factor, or prime mover, it should again be expected that urban forms in other arid regions would also display similar morphology.

The hypothesis for the preponderance of grid-like street systems that seems to be supported the most by physical evidence suggests that the form originates due to agricultural irrigation practices. This idea was first proposed by Bonine (1979) and has since been largely endorsed.

As described above, *qanats* are a major means of providing water to settlements and agricultural fields in Central Iran. Surfaced *qanats*, streams called *jubs*, provide irrigation to the agricultural fields by means of ditches that commonly branch off from the main *shahjub* towards the downward grade of the terrain. These secondary *jubs* often also have tertiary *jubs* that branch off to form a somewhat complex mesh of irrigated strip or rectangular fields. The systems of irrigation networks vary in the rectangular regularity, the reasons for which have been variously ascribed to changes in socio-economic situations (free peasantry in the case of irregular, and landlord-controlled fields with more rectangular fields) (Bobek 1976) or technological changes for improved yield in response to population pressure (Bonine 1989).

The alignment or orientations of the field system are strictly determined by the contours of the topography (Bonine 1989). While the forms of this agricultural field system are consistently rectangular, three broad variations have been identified; a) the block system, b) the narrow strip system, and c) the hybrid block strip system (Fig. 17). In addition, the former two systems have more specific sub-types (Bobek 1976).

Urban settlements are located where the *qanat* surfaces to become the *shahjub* that flows through the settlement. The agricultural fields commonly surround the settlement or both sides of the *shahjub*, but there are also examples where the agricultural fields are located down-slope to one side of the settlement (Bonine 1989). Depending on the size of the settlement, the water may be subdivided to a number of main channels through a distributor called a *maqsam* (English 1989). The water

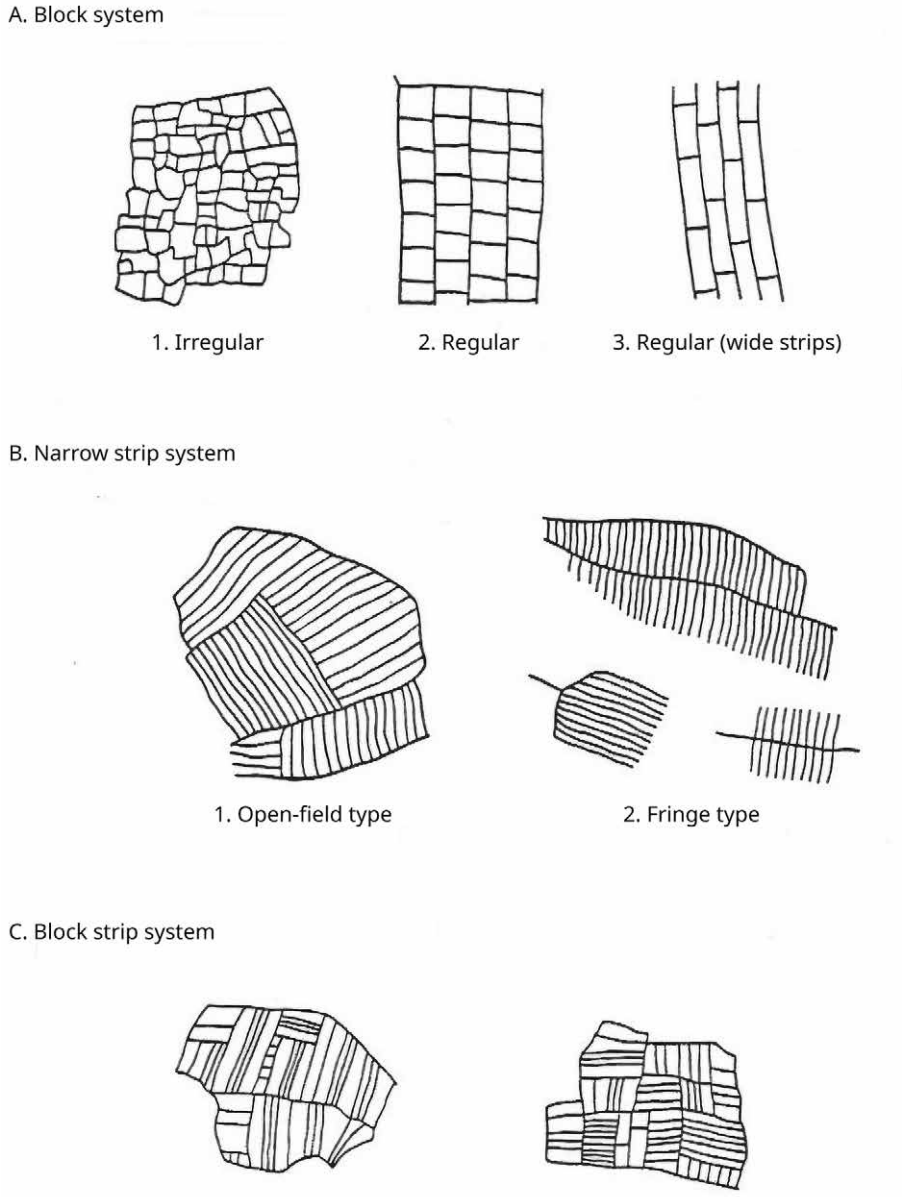


Figure 17. Forms of field irrigation systems (after Bonine 1989).

is apportioned among the shareholders of *jubs* and fields by time-shares that occur in cycles, of which the length of time varies between villages and regions (Bonine 1996). The water is let in by sleuth-gates and is regulated by the *mirab*, the person in charge of measuring the allotted time with a water-clock or sun-dial (Honari 1989).

In addition to agricultural use, the water provided to a settlement by a *qanat* is employed for other uses as well, though there is a hierarchy of the distribution according to the sanitary requirements for the water. Water for drinking and cooking is prioritised and it therefore flows into covered circular reservoirs called *ab-anbars* (Kheirabadi 2000) or even ice-houses, which are often located near the *mazhar*, where the *qanat* surfaces at the head or centre of the settlement, or along the *shahjub*. Mosques are also commonly found in the vicinity of the main surface channel in order to have access to clean water for ritual bathing (Honari 1989). The water is then channelled to shallow pools for other domestic uses such as

washing implements before it is then apportioned to *hammams* for public bathing. Thereafter, the water might be used to power a mill or apportioned to the use of forming mud brick. Finally, it is diverted for use in irrigating agricultural fields and gardens. Access to fresh water can also produce spatial gradients with respect to social hierarchy and locational desirability. Wealthy and powerful inhabitants are usually located near the source of the water where it is still clean. The further the distance from the source of the water the less desirable the land will be, and thus the residents are less well off (Bonine 1996).

4.7.2 Central Asian cities

As with the discussion of East Iranian urbanism, this section will primarily cover urbanism in Central Asia during the Early and Middle Islamic periods, although urbanism in the late antique periods is also addressed where necessary. Urbanism in Central Asia began to transform after the conquest increased the population significantly with Arab settlers who brought a new state system with them with different urban needs and requirements. However, there does appear to be

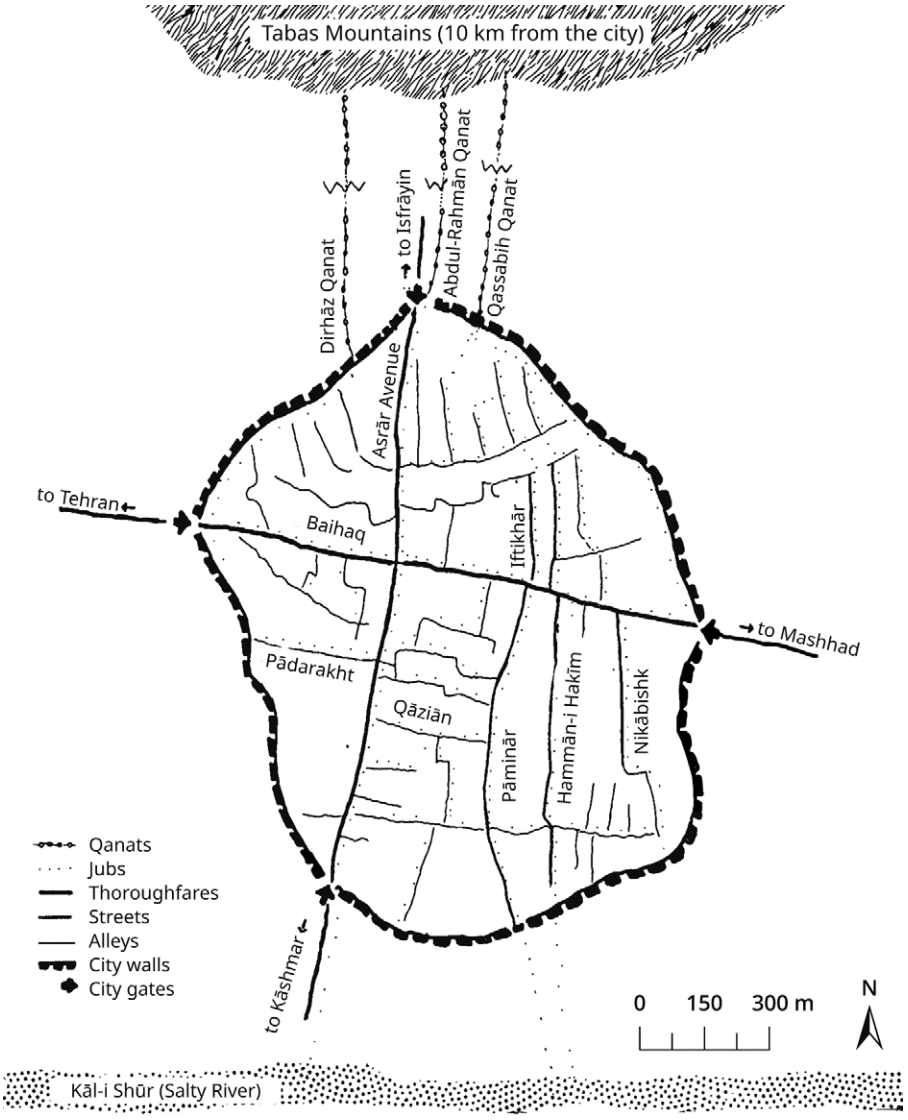


Figure 18. Schematic of the street and *jub* pattern in traditional Sabzivar (after Kheirabadi 2000, 33).

some morphological continuity in urbanism between the late antique and Early Islamic periods.

In contrast to the bipartite structure of many Arab and many Iranian cities, many medieval cities in Central Asia have been found to be tripartite – and even quadrapartite according to Sobti (2005) – in form. In addition to the walled *quhandiz* and *shahristan* of Iranian cities, many Central Asian cities had significant walled suburban parts outside the *shahristan* walls, called *rabad* or *birun* in Persian. This tripartite scheme was first identified by Bartold (1928) and has since been widely accepted. Indeed, it is an apt scheme as outlined in a passage from al-Istakhri's *Al-Masalik wa-Mamalik,* in which he describes the topography of cities in Fars with

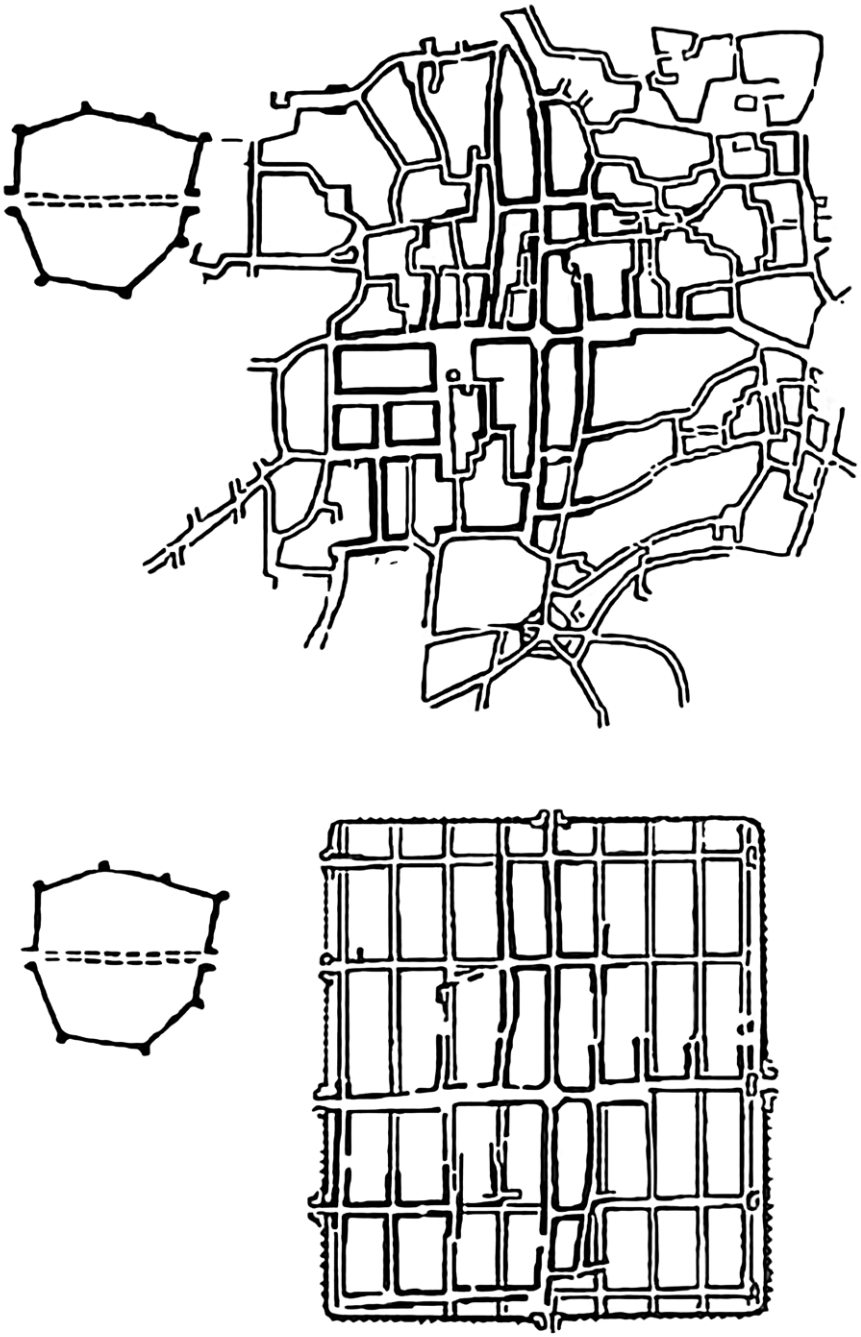


Figure 19. A reconstructed schematic of medieval Bukhara's grid-patterned streets (below), based on a 19th century plan. Note the citadel to the left of the *shahristan* (after Sobti 2005, 34).

just such a scheme, signifying that this urban form may be present further afield than just in Central Asia.[50]

It seems, however, that the antique form of cities in Central Asia was bipartite, as the tripartite form developed after the Muslim-Arab conquest of the region (Sobti 2005). The average pre-Islamic city was comprised of only two walled sections, the *quhandiz* and the *shahristan*, just as with their Iranian analogues. They are distinguished, however, by their particular form and arrangement. The outward form, exhibited by smaller urban-like settlements as well as definite cities, is generally quadratic. The *quhandiz* of these settlements – also commonly quadratic – are usually situated in a corner within the *shahristan* almost exclusively on the northern edge.[51] In terms of urban fabric/tissue, the urban settlements tend to exhibit street systems that are predominantly arranged at right angles oriented to the cardinal directions, which in many cases are likely due to the presence of *jub-qanat* lined street systems of Iranian urban settlements. Pools of water, salt flats, and gardens are typically found near the perimeter of the settlements. Larger settlements may have two main streets that are cardinally oriented and intersect in the centre of the settlement.

Such notable cities that display this morphology to varying degrees include Herat, Bukhara (Fig. 19), Paikend, Bam, Gyaur Kala, and numerous other smaller fortified *qala*-like settlements that pepper the landscape in the vicinity of cities. Because of the Muslim-Arab conquest of the region and Arab settlement, however, many of these urban settlements had substantial suburbs, which developed to incorporate many of the amenities of the *shahristans* and so either eclipsed them as the main part of the city, or became an additional urban core (Sobti 2005).

4.7.2.1 Building materials and methods

Because there is a scarcity of stone and timber on the plains of Central Asia, the primary building material has been soil throughout the urban history of the region and continues to be a common material for vernacular construction. Depending on the purpose of the structure, using differing combinations of wet silt, sand, clay, and organic fibrous materials – a material known as 'cob' or 'adobe' – various methods can be employed in the building of earthen architecture. Perhaps the simplest method is that of hand moulding. In this method, layers of cob are laid down by hand and allowed to dry in order to form non-load bearing outside structures such as walls for an enclosure (Herrmann 1999).

One of the most common manners for earthen material to be used is in the form of sun-dried mud brick. In the past, sun-dried mud brick was used for all forms of architecture, from domestic vernacular architecture to monumental structures. Unlike 'adobe' or 'cob', the mud used for bricks in Central Asia does not necessarily include fibrous organic materials.

The most rudimentary method of forming bricks is through hand moulding, but placing mud into wooden moulds to dry is also common (Fodde 2009). As there was no standardisation in place, sizes and shapes of the bricks vary regionally, temporally, and even between structures of the same site. For instance, pre-modern brick sizes vary from 400-410^2× 110 mm to 210^2× 70 mm at Merv (Herrmann 1999).

50 Al-Istakhri also describes *madinats* with *husun* (citadel, fort, fortress; singular *hisn*), and interestingly some fortified settlements with *rabads* but without a *shahristan*.

51 Bartold claimed that the citadels were most commonly found in the northwestern corner, which may be the case, but this indicates a random pattern rather than signifying an intended form as a not insignificant number of counter examples exist.

Figure 20. GIS map of Gyaur Kala showing the intersecting main streets and the built-up area (Source: created by the author with QGIS 3.12, Bucuresti. Map imagery © Microsoft Bing Maps and its data suppliers).

Generally, the earlier the structure the larger the bricks tend to be, and thus the size of bricks has been used as a means of dating structures. There are exceptions to this pattern, however, and so this method of dating cannot unequivocally be relied on. Fired mud brick was also used as early as the 6th century in Central Asia (Fodde 2009), but was more widely employed by the Seljuks after the 11th century (Herrmann 1999). This material was not ubiquitous, however, as it was more labour intensive and required the consumption of fuel that was of limited supply in the region. Fired brick was primarily used on the facades and foundations of formal monumental structures because of its greater longevity over unfired mud brick (Herrmann 1999).

The final method of utilising soil as a base building material to be mentioned is rammed earth, also known in the western hemisphere by its French appellation *pisé*. Called *pakhsa* in most of Central Asia, rammed earth is formed into large blocks by placing damp soil – usually clay – and occasionally straw into a large form and tamping it in successive layers with a flat ended ramming pole until the soil is compact. *Pakhsa* in Central Asia was historically most commonly used for the foundations of structures or bases of walls, though it was sometimes used for wall interiors as fill (Fodde 2009).

Timber was not widely utilised in Central Asia as a construction material until the establishment of the Timurid Empire in the late 14th century, in which it was then used for both decorative and structural purposes, especially in roofing of monumental structures (vaults and domes being the principle architecture for roofs before this time). Timber was also used in a structural capacity as 'tie-beams' for walls by the Seljuks (Herrmann 1999). Timber and organic materials were used

in vernacular/domestic structures for the supporting framework of flat soil roofs, much as they still are today (Fodde 2009).

Earthen architecture presents a number of problems for archaeology. Although soil is a versatile construction material, it is not particularly durable and does not preserve form well. Earthen architecture is easily susceptible to degradation by dampness and wind, and thus requires constant maintenance. Some earthen architecture can be partly preserved by being partially buried by wind-blown deposits, but wind and rain have a discernible erosive effect on the surface of structures. Additionally, dampness and wind erode the base of walls more quickly than the rest of the structure, a process known as 'under-cutting'. This causes walls to collapse in one direction rather than simply eroding down to leave discernible walls lines (Friesem *et al.* 2011). Altogether, most above surface earthen architectural features are not long-lived, and those that do survive a considerable time are usually of monumental scale (Herrmann 1999).

In addition to natural processes that spoil earthen architecture and muddy its interpretation, there are human practices that achieve the same. On the one hand, in comparison with modern Western sentiments, in the Early Islamic culture of Central Asia, and perhaps much of the pre-modern Islamic world, there was not as great an emphasis placed on the importance of conserving structures. Elites were more inclined to construct their own grand dwellings than to occupy and preserve the structures of their predecessors (Herrmann 1999). On the other hand, further complications arise from the practices of reuse and repurposing. It was common practice in Central Asia to raze old structures when no longer wanted or in disrepair and to use that material as the foundation for a new structure. Additionally, material from abandoned structures was frequently used to remake construction material, and so rendering any inclusions in surviving earthen structures, such as ceramics or organics, of little use in dating (Herrmann 1999).

Chapter 5: Methodology

5.1 Data collection: Aerial and remote sensing data

5.2 Site data

The majority of the data used to map and analyse the site of Merv was sourced through various methods of remote sensing. Data from excavations was used, and in some cases was helpful for more accurate mapping, but it was more beneficial in revealing the developments in particular areas. From remote sensing methods, the primary data used was acquired through vertical aerial photography (AP), of which there were two sets: a collection of prints from a Soviet survey conducted in the 1970's, and a digital set from an unmanned aerial vehicle (UAV) survey conducted in 2011.[52]

The Soviet AP was of limited use due to incomplete site coverage and low resolution, but did have some excellent contrast by which to more easily discern and distinguish surface features. Additionally, the site has suffered quite rapid erosion in the last 70 years and so the definition of the surface features in the Soviet AP in some instances was much better and more easily discernible than

52 Both of these data sets were generously provided to me by Tim Williams and Gai Jorayev of University College London, Institute of Archaeology, of whom the former conducted the survey and collected the data (Williams 2012).

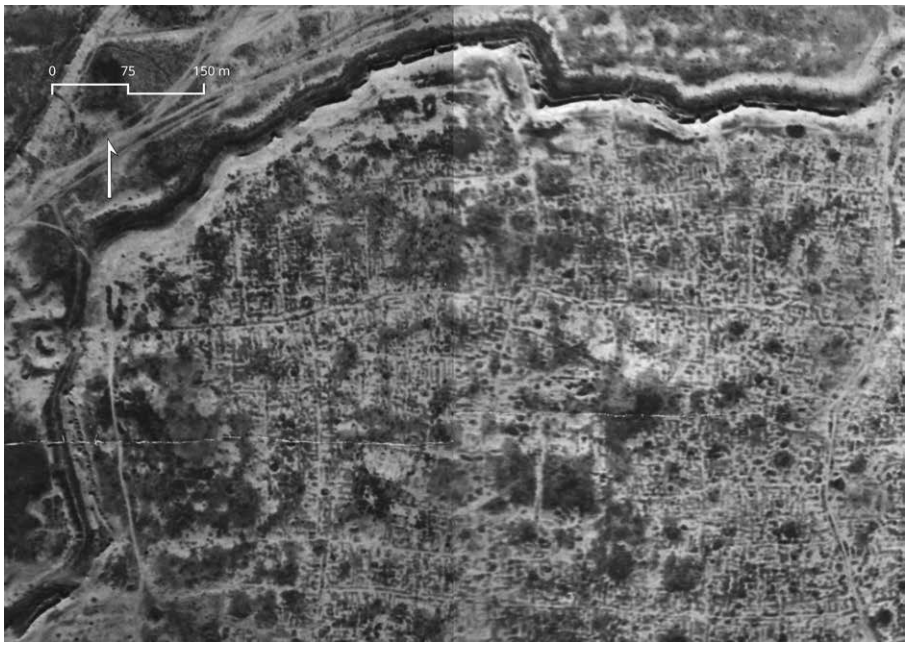


Figure 21. A sample of the Soviet aerial photography showing the northwestern section of Sultan Kala's *shahristan* (Source: after Williams and van der Linde 2008; DOI:10.5284/1000164).

Figure 22. Satellite imagery from Google Earth Pro 2024 (using historical satellite imagery taken in 2013) illustrating the effects that environmental conditions can have in emphasising the relief in the topography (Source: Link provided by the author: https://earth.google.com/web/@37.67063828,62.16322629,233.94006836a,2106.58085512d,35y,359.99279904h,0t,0r/data=ChYqEAgBEgoyMDEzLTAxLTIwGABCAggBOgMKATBCAggASg0I_____ARAA).

in some of the later AP data sets. Thus, this data set was useful for reference and comparison (Fig. 21).

The AP data collected by UAV was the most useful of any of the data used in this work. The survey was conducted by UCL, Institute of Archaeology by using a type of fixed wing drone called a *swinglet* CAM, manufactured by a company called sense FLY LLC and affixed with a 12-megapixel digital camera, GPS, and radio receiver. By flying a pre-programmed route in the form of transects over the site, it gathered roughly 3,500 photographs of 2 cm resolution and 2,000 of 4 cm resolution. During post-processing of the data, the photographs were 'stitched' together to produce a number of geo-referenced orthomosaic GeoTIFF 'tiles'. From the orthomosaic tiles, a number of digital elevation model (DEM) tiles and 3D mesh models were also produced (Williams 2012).

In addition to the use of the aforementioned data sets, open access satellite data, such as *Merv, Turkmenistan* (2016)[53] and *Merv, Turkmenistan* (2020), were also used. The historical imagery function of Google Earth was particularly useful in that the different environmental conditions, due to different times of day and year when the images were captured, enhanced the contrast in the varying relief of the site (Fig. 22).

Non-remote sensing data came in the form of season reports from the International Merv Project (1995-2000), the Ancient Merv Project (2001-2002), and excavation and field reports by YuTAKE. The use of the latter was limited as not all of the reports have been digitally scanned and translated, and the archaeological methodology and reporting that was presented in those that were digitally scanned and translated did not use modern standards, making certain descriptions ambiguous.

5.3 Data processing, visualisation, and organisation

For better or worse, there is no comprehensive standard approach in archaeology for the visualisation and interpretation of aerial imagery. Rather, there are only outlines of 'best practice' and limited conventions when it comes to aerial data visualisation, organisation, and cartographic representation. This is expected when considering the particular limitations of disparate projects: site conditions, data type and quality, and project aims will all vary. Naturally, effort has been made to adhere to 'good practice' and conventions, when appropriate, but more importantly care was taken to document the process of the data interpretation and manipulations for transparency (Kokalj *et al.* 2013).

The manipulation, transcription, and analysis of the UAV data and archaeological features was carried out using QGIS version 3.12 Bucuresti. Because it is open-access and thus available for the public to modify and develop additional functions ('plugins'), QGIS was chosen for the project over its popular paid license counterpart ArcGIS, to which it is very similar.

5.3.1 Raster layers

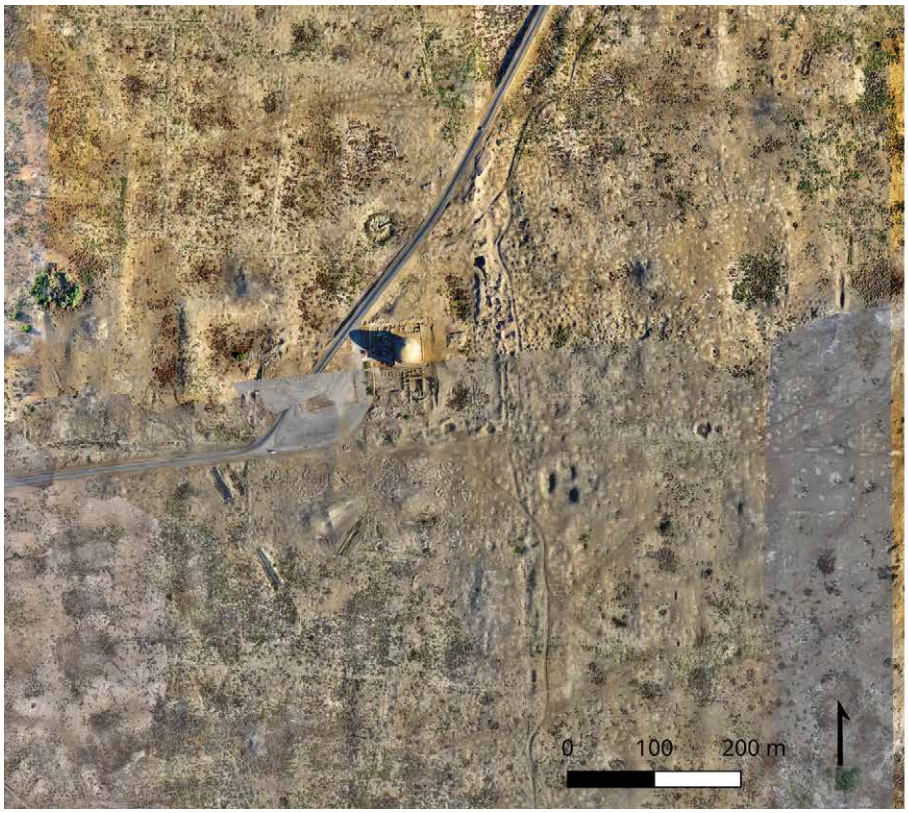
The post-processing of the raw UAV data had already been completed when it was provided for this project in the form of raster files of two types: multi-band (RGB) photographs and DEMs in GeoTIFF files. As previously mentioned, both the multi-band data and DEMs were provided in a number of tiles and attempts were made to 'stitch' and 'clip/crop' the tiles to provide a whole base-map of the site so as to facilitate further processing and analysis. But due to a number of digital artifacts, noise, and slightly different z-values[54] between some of the data/tile images (Fig. 23), no satisfactory results were produced.

'Seams' were ever-present in the results, and the slightly different z-values were visible in adjacent 'heat-map' tiles, which produced a visually confusing base-map for interpretation (Fig. 24). Thus, a Bing-sourced satellite image was used as a base image[55] on top of which the individual tiles could be used for more detailed analysis.

53 Images taken on February 24, 2016 and January 20, 2013 were used as they were found to particularly well depict the microtopography of the high-resolution satellite images available between 2012 and 2018.

54 Some of the noise was removed and 'no-data' values filled using native QGIS features, with limited success, but nothing was found to be done with the artifacts or differing z-values.

55 © Microsoft, Bing Maps, and its data providers.



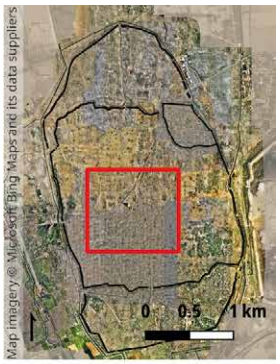
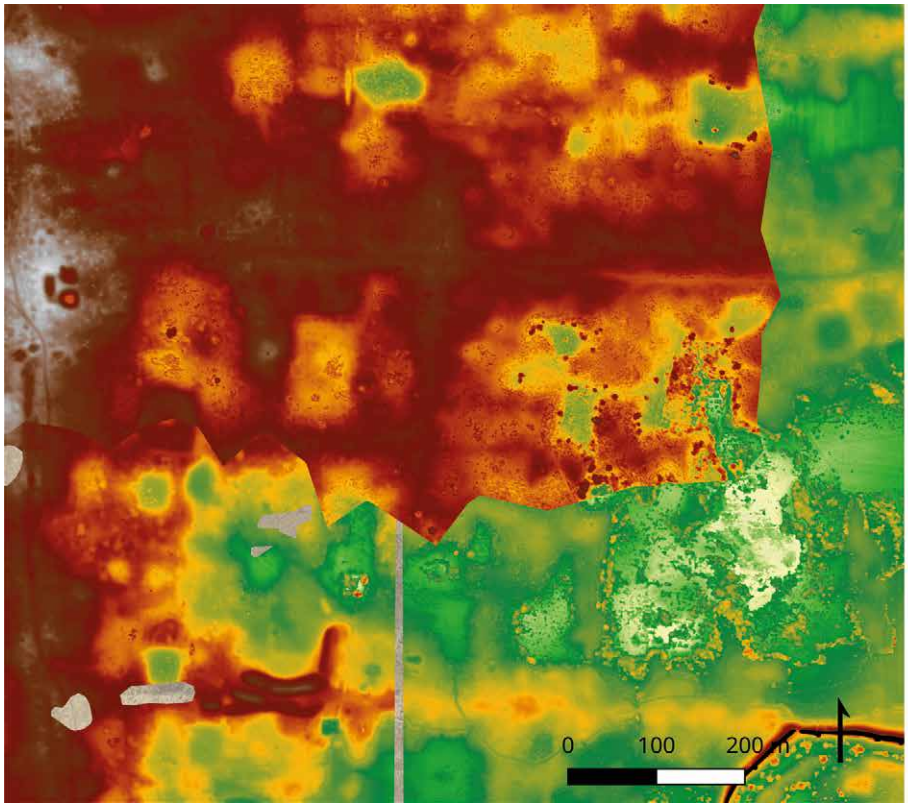


Figure 23. A close-up sample of the RGB tiles showing the visual discrepancy between them. Also shown is an overview (top right) of Sultan Kala comprised of RGB tiles (the ramparts are outlined for clarity) (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).



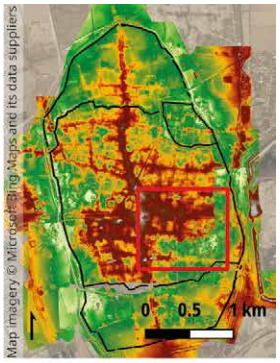


Figure 24. Close-up and overview maps showing the visual discrepancies between the DEM tiles using heat-maps (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

Of the individual tiles, GIS image enhancement methods were performed to augment the relief of the terrain visible in the data. With the multi-band data, this relatively meant simple adjustments of the colour saturation and contrast to achieve the desired degree of enhancement. This was not performed to a specific standard as the desired effect was subjective and the image properties varied between the tiles due to them being taken under different environmental conditions. Contrast was also enhanced in some instances when the RGB images were converted to grayscale.

In comparison to the RGB images, the processing and the visualisation of the DEMs were more demanding and complex as there were more approaches possible. Before exploring different approaches to visualisation, attempts were made to filter – also known as smoothing – the DEMs to produce digital terrain models (DTM).[56] Different methods of smoothing were attempted (Nearest Neighbor, Cubic Convolution, and Bi-linear) but none of these produced satisfactory results; the intensity of smoothing (iterations of filtering) required to remove the vegetation smoothed the shallow relief of the site making the DEM less useful.

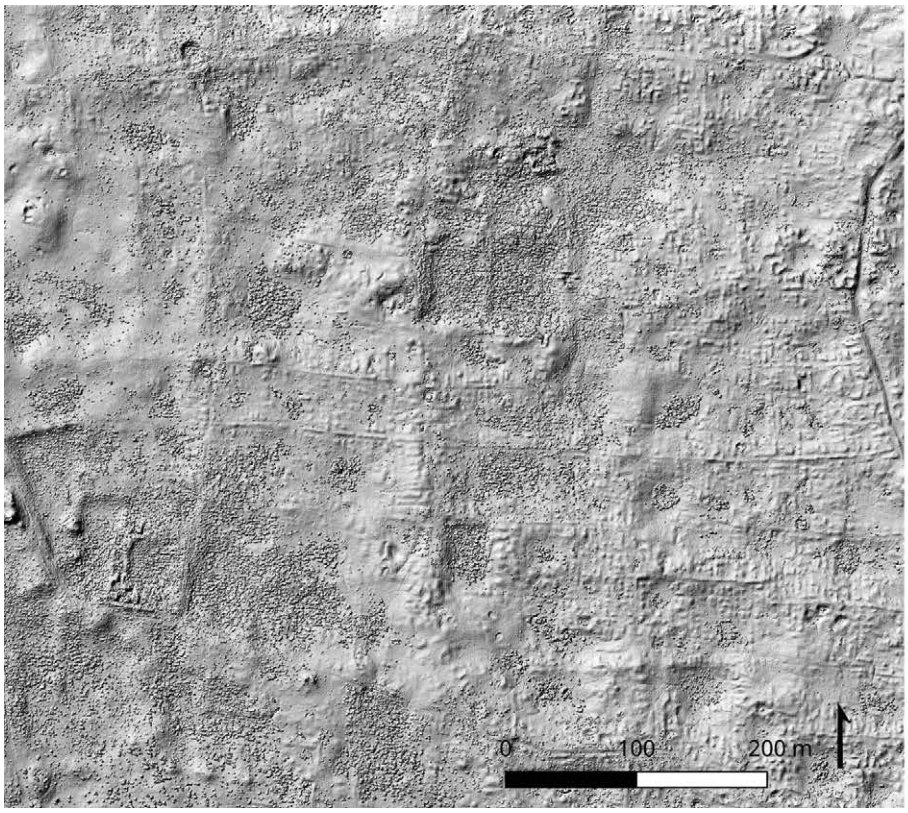
Three different methods for visualising the DEMs in three layer groups were used as their utility and ability to highlight the landscape differed. DEMs are commonly used in landscape archaeology, though more often on a larger, more regional scale than in this study. Applying a 'hillshade' – also called 'shaded relief' – to the DEM is frequently the primary way of aiding visualisation. For the initial layer group, hillshading was applied to all of the DEM tiles with a light source with an azimuth of 315 (north-west) and an altitude of 45, which are both typical parameters for a hillshade (Conolly and Lake 2006), although it was also found to be visually useful to occasionally adjust this up to 55. Additionally, the 'z-factor', which exaggerates the elevation, was adjusted to 3 in order to further enhance the shading effect on the relief of the terrain (Fig. 25).

The second layer group consisted of multi-directional hillshaded tiles (Fig. 26), which combated some of the relief ambiguity (concavity or convexity) and further enhanced the relief in many areas of the site (Palmer 2013).

The final layer group consisted of the DEM tiles rendered as colour-shaded heatmaps using topography colour-ramps in order to visualise the elevation variation across the site (Kokalj *et al.* 2013). This too helped to lessen some of the relief ambiguity. The raster data described above was organised in layers and layer groups, which are provided in Appendix II, Table II.1.

The particular arrangement of the layers was done in such a way in order to facilitate the comparison of images from different layers by toggling between them, as well as to blend images with others. Soviet aerial images display some topographical features in less eroded state than the later UAV data, and thus they were more apparent. Additionally, while the photograph plates were georeferenced, in some areas they were slightly misaligned with the more accurate UAV data. For these reasons, the Soviet photographs were placed as the first raster layer group for quick comparison with other images/layers below. The RGB and heatmap raster layers were placed above the

56 Technically, the DEM tiles are digital surface models (DSM), meaning that they include man-made objects and vegetation. Filtering them into DTMs would have removed the vegetation, thereby revealing only the surface topography and making archaeological features more easily 'readable'. 'Smoothing' uses 'low-pass' filters, which de-emphasise the variation in the landscape. The low-pass filters are algorithms that average the values – z value, in this case – of pixels in a specified neighbourhood (Conolly and Lake 2006).



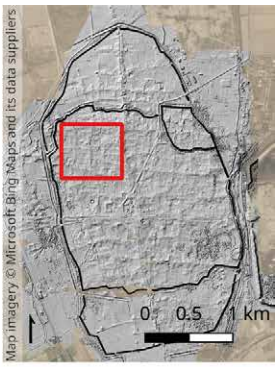
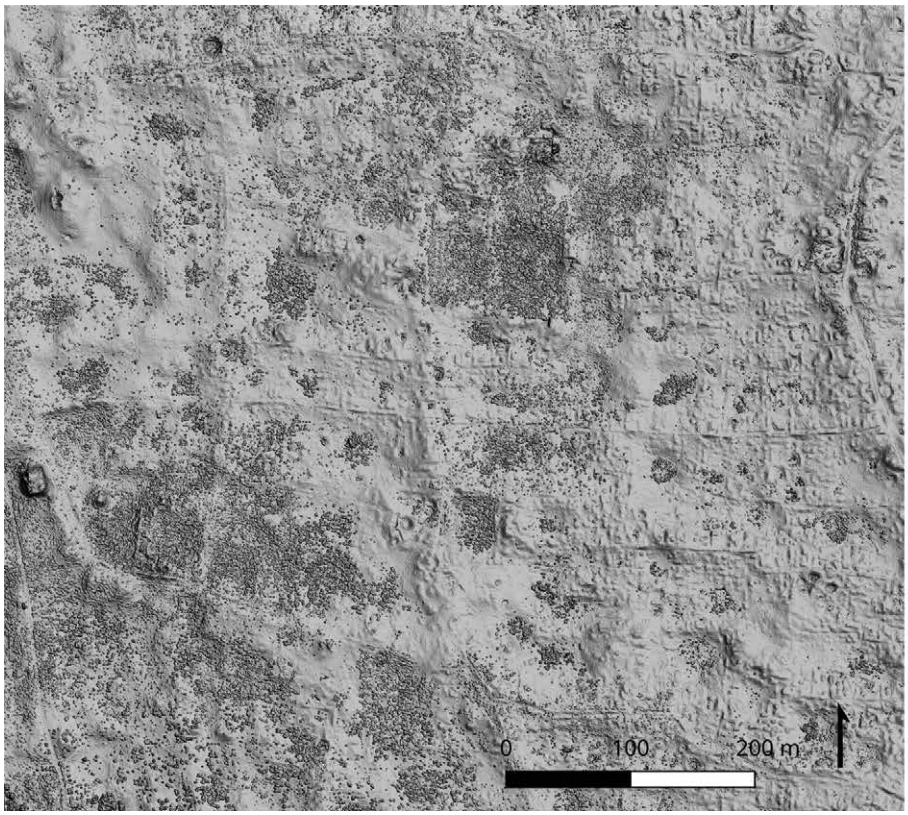


Figure 25. Detail of a hillshade and a hillshade overview map. Light source is at 315° (north-west) at an altitude of 45° (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).



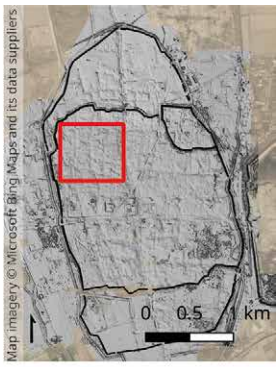


Figure 26. Detail of a multi-directional hillshade tile and an overview map (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

Characteristics	Description	Cause
Soil tone/colour	Comparative brightness and hue of the soil.	Composition of the soil matrix and/or degree of water saturation.
Soil texture	Variation in the pattern and frequency of tone.	Compaction (evenness and roughness) of surfaces.
Lighting/shadow	Displays the relief in the terrain.	Uneven surface of the terrain and the position of the source of light.
Shape	The form of distinct features.	Rectilinear forms are often anthropogenic.
Pattern	The spatial arrangement of shapes/features and/or tones and textures.	Suggests the presence of a related group of features, such as a structure.
Association	The spatial relationship between features and identified pertinent feature(s).	Proximity is often intentional, and may denote a relationship between features and feature function.
Size	Relative and absolute function of scale.	Size is often related to function.
Vegetation	Varying pattern of plants grown within the landscape, both in the form of presence/absence and habit/degree of growth.	Soil compaction and degree of drainage, caused by subsurface features.

Table 2. Visual characteristics of the terrain.

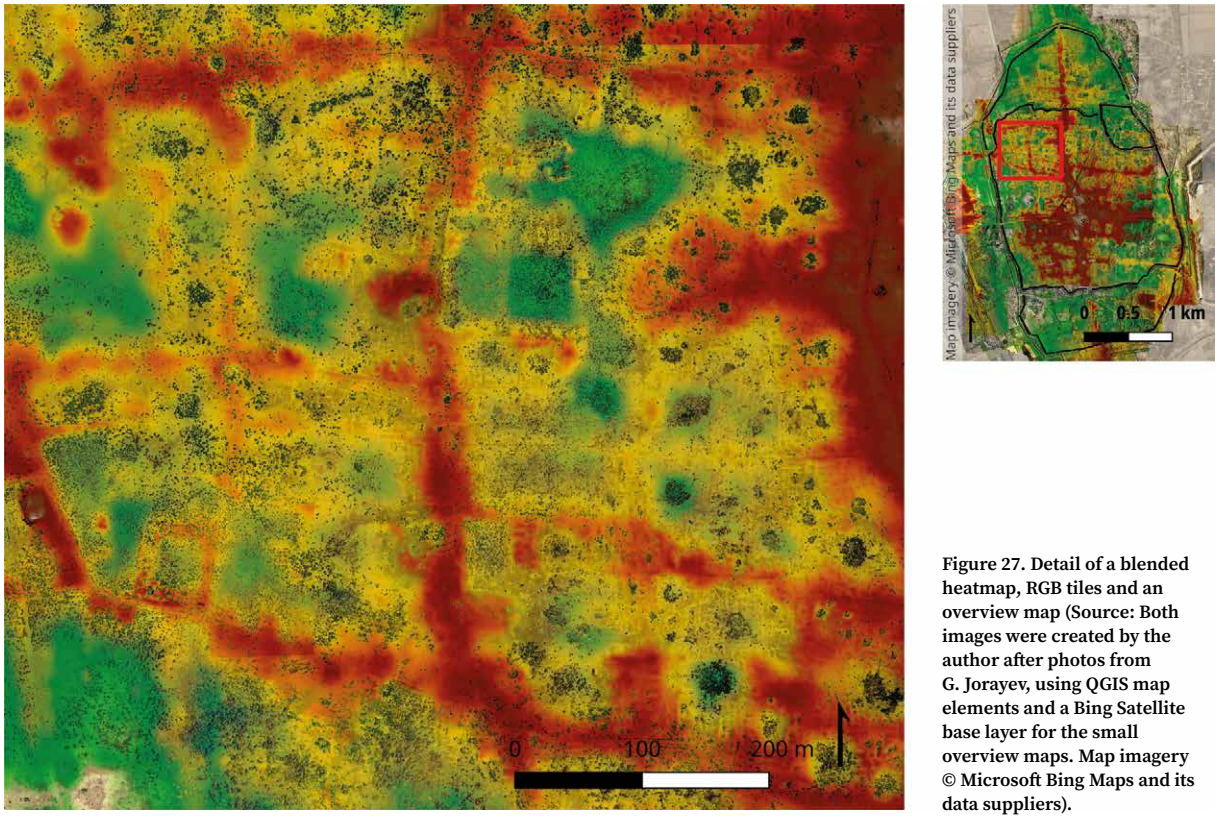


Figure 27. Detail of a blended heatmap, RGB tiles and an overview map (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

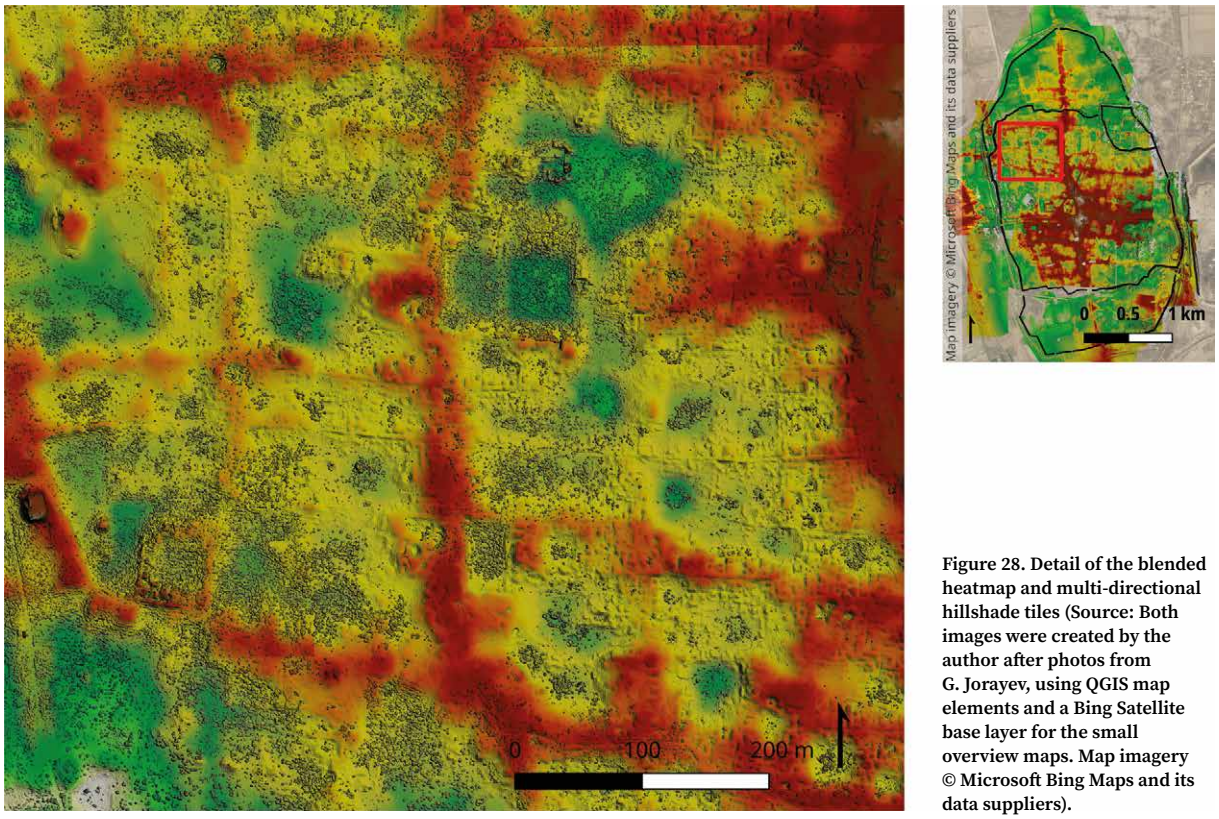


Figure 28. Detail of the blended heatmap and multi-directional hillshade tiles (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

hillshade as they both blended[57] extremely well with the latter raster layers to produce detailed and easily intelligible images of the topography (Fig. 27 and Fig. 28).

There were attempts to 'drape' the RGB rasters over the hillshades using the GRASS' r.shade plugin/algorithm in order to make the RGB images appear 3-dimensional, however, this never succeeded in producing a new raster layer (possibly due to persistent digital artifacts), and the results from blending the layers was satisfactory. The final raster layer was the Bing Satellite base map that was used for locational context when only some of the tile layers were selected. Bing was chosen over other satellite image base-maps offered through QGIS' QuickMap Services, such as through Google and ESRI, as it presented the best compromise between resolution and topographic contrast.[58]

5.3.2 Interpreting the aerial images and topographic data

Unfortunately, archaeological material is not self-evident from viewing the topography of the landscape through remotely acquired data. By comparing a number of qualitative characteristics of the topography, the underlying archaeology can be better detected and made apparent. Characteristics such as soil tone/colour, soil texture, lighting/shadow, vegetation, shape, size, pattern, and association affect the detectability of archaeological features[59] (Lasaponara and Masini 2012; Williams 2008).

57 This is a native function in QGIS' layer 'properties' tab that offers multiple options for different blending modes. In this case, 'darken' was perceived to have the best appearance.

58 Google Earth Pro's Historic Imagery function did have better quality satellite images, but this function is not available through the QuickMap Services.

59 Naturally, soil tone and texture are not characteristics present in three dimensional topographic models.

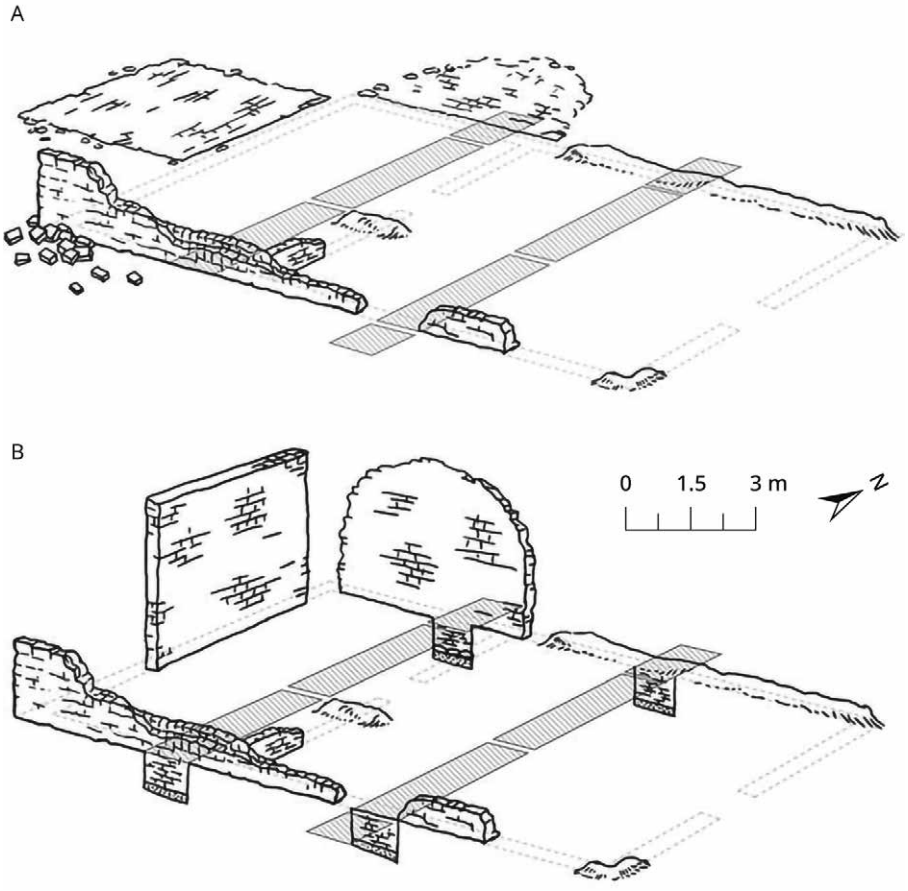


Figure 29. An illustration of the pattern of collapse of a mud brick structure (A) and after it was excavated and re-erected (B) (after Friesem 2011, 1137).

Varying physical conditions will affect how these characteristics (see Table 2) are expressed and how they should then be interpreted. For instance, contrast can be affected by soil tone, soil texture, and shadow. It has been noted that archaeological residues and buried structures will spectrally appear lighter than the surrounding or off-site soils and also contrast when a state of 'drying out' is present (Beck *et al.* 2007). This is likely due to soil compaction and differences in moisture retention between archaeological and non-archaeological materials. Lighting is, as expected, affected by the time of day and year as well as atmospheric conditions. Vegetation aids in detection by its tendency to proliferate in depressions where moisture collects, and is absent or displays distressed growth, in contrast to surrounding vegetation, when grown over buried structures (Lasaponara and Masini 2012).

Particular patterning and shapes in the aforementioned characteristics of the topography were used to detect and identify archaeological features. Just as a sound understanding of what classes of features are to be expected is necessary for detection, so too is an understanding of the formation processes of these archaeological features. Naturally, the manner in which archaeological features form is dependent on the material(s) present. As mentioned before in Section 4.7.2.1, the overwhelming material present at Merv that was used for constructing buildings is sun-dried mud brick and rammed earth, with fired mudbrick in a few cases. Intuitively, sun-dried brick and rammed earth are notably susceptible to degradation from reactions with the environment, mostly from water – either in the form of rain or ambient dampness – and wind erosion. Biological factors too, such as plant root growth and burrowing critters, can advance the degradation process. The way in which mud brick walls degrade will vary across a site or structure due

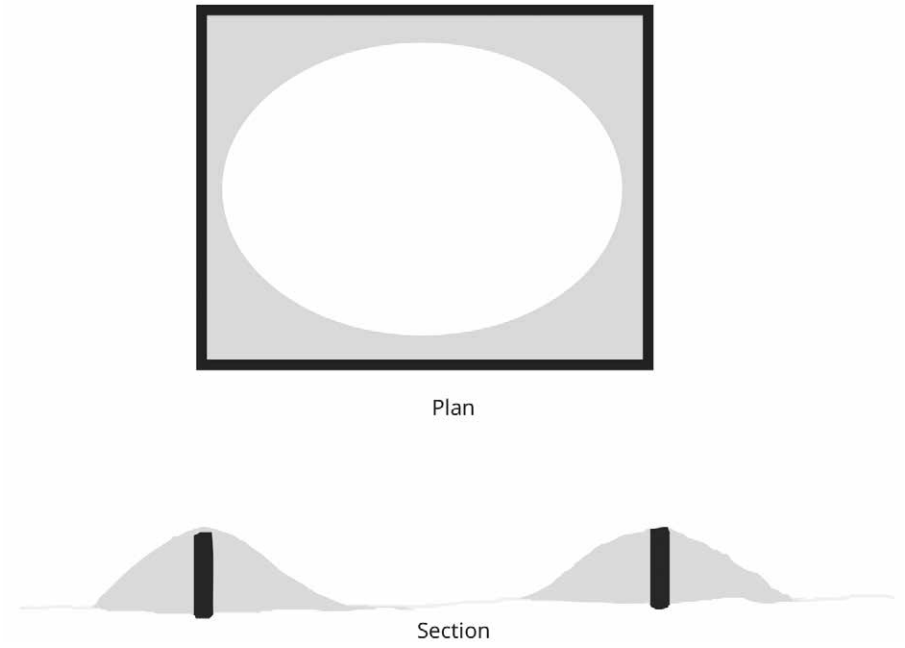


Figure 30. An illustration of the formation process of courtyards that results in an oval form (after Williams 2008; http://intarch.ac.uk/journal/issue25/1/4_3_2.html).

to very specific conditions. Walls can degrade by individual bricks, or processes of 'undercutting' generated by water movement and wind erosion at the base of walls will cause them to collapse both outwardly and inwardly (in relation to walls that are part of the form of an enclosed building).

In terms of buildings and houses with courtyards, research has demonstrated that more debris and sediment tend to accumulate within the previous roofed areas of the buildings in comparison to the courtyard, and overall compared to outside the building (Friesem *et al.* 2011) (Fig. 29). This makes internal courtyards form an oval shaped depression in which vegetation commonly grows due to the tendency of the depression to collect moisture (Williams 2008) (Fig. 30). It can reasonably be assumed that rammed earth erodes similarly to sun-dried mud brick, and thus displays similar formation processes. Fired mud brick, however, has demonstrated to be much more durable, and likely produces less debris and fine sediments than unfired earthen building materials.

The formation processes just outlined are readily present at Merv. The walls of the dozen or so partially standing monuments, such as the Kepter Khana, Greater Kyz Kala, and city walls, are subject to undercutting (Barton 2009). The vast majority of the previous structures have already collapsed and eroded into mounds interspersed with the distinctive vegetation-filled depressions. The depressions range in size from small courtyards/rooms to wide open areas. The larger depressions vary slightly in their elevations and are interspersed with vegetation. It is assumed that these areas represent less 'built-up' areas, as there was presumably less material to degrade and collect.

5.3.3 Feature transcription

The 4 cm and 2 cm resolution of the aerial photos displayed impressive details of the site.[60] Intuitively, there is great potential to use such detailed and complete coverage of the site for documentation, interpretation, and analysis. Ideally, the intention would be to transcribe the plans and wall-lines of sub-surface structures, yet this did not prove to

60 The 2 cm were even found to be excessive as the size of the files were laborious on most computers, as well as having an unnecessary degree of detail for anything other than the partially standing structures of the site.

be possible. The primary reason for this was the easily visually bewildering corrugated topography of hillocks of depressions interspersed with vegetation. The mounds do not form traceable linear wall lines and any coherent structural pattern could not be identified from the microtopography. The exceptions to this are the long depression and linear arrangements of mounds interpreted as water conduits/paths, and a few cases where the outline of large courtyard structures can be discerned. Additionally, the cluttered/messy landscape would likely carry over into the transcription and thus useful and coherent maps would not be produced (Mlekuž 2013).

Finally, the intention of this study is not to focus on fine detail, but to reveal larger structural and developmental patterns of the city. Focusing on the microtopography could impede making broader interpretations by narrowing perspective and context. It was therefore necessary to shift towards a method of transcribing topographical features as relatively simple topologically shapes and lines.

The varying degree of perceptibility and identification of patterned archaeological features resulted in five classes of transcribed features. Two of the classes were the primary features for later analysis: polygons that would represent different urban categories of voided space, and poly-lines representing linear features that symbolise paths, walls, and different kinds of water conduits (*jubs*, sub-surface piping, and canals).[61] The other classes would also be transcribed as polygons and represent monuments (partially standing structures), major structures of which the plan could be discerned through topographic relief, and anomalies (features or areas that had distinct patterns or shapes but could not be identified). While these other feature classes would be used for analysis, they do not comprise the bulk of the pertinent data. The remaining sundry transcribed features are individual layers, and depict the Majan Canal, locations of previous excavations, features that likely collect(ed) water, and city walls (see the QGIS Project to refer to the feature layers and their structure).

5.3.3.1 Topography and topology

Voids/open spaces were transcribed as polygons, excluding linear features. Any recognisable outlines of structures would also be transcribed as simple polygons. The process of erosion and mounding left the edges between structure and voids indistinct, and so the boundaries/dimensions of voids – and consequently also the sizes – could only be approximated. This concession was considered acceptable, however, as the significant information for interpretation and analysis would be preserved in relative sizes and dimensions. Naturally, the vagueness in boundary also meant that the shapes of features were also somewhat ambiguous, especially for larger depressions that appeared more topologically complex. In these cases, too, the relativity of features' shapes would have to be used for interpretation and analysis.

Ambiguity was also present in transcribing linear features, which were exhibited in three ways: linear features with a high degree of clarity, topographical patterning of features roughly in linear arrangements, and projected linear features in which no linear feature was observed although a connection between two observed linear features could reasonably be inferred.[62]

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61 In urban morphological theory, path and street space are also considered voided or open space. The decision here to transcribe linear features with poly-lines was made for two reasons: 1) In many instances, the identification of the linear features as streets/paths was equivocal, and 2) the topography did not exhibit definitions clear enough to accurately transcribe paths as convex space.

62 The original intention for this project was to conduct on-site fieldwork in order to 'ground-truth' or assess the accuracy and effectiveness of transcribing the linear features and voids through ground-penetrating radar (GPR) surveys and detailed surface documentation. In fact, excursions to Merv were fully planned for two summer field seasons in a row. However, a number of difficulties and setbacks prevented the implementation of both excursions.

5.3.4 Feature interpretation and creation of urban elements

5.3.4.1 Voids/open spaces

Three criteria were used to aid in specifying the use and function of a transcribed void: size/scale, shape, and relative position. The parameters for the criteria were heavily informed by general urban theory and models of medieval Islamic cities, historiographic sources, and medieval Islamic architecture. Two schemes were used conjunctively to classify the transcribed voids/open spaces by use and function; one with the purpose of analysis according to general urban theory, and another more informed scheme specified for analysing Islamic cities. For the former scheme, concepts were taken and modified from the typology put forward by Stanley *et al.* (2012) (Fig. 31). In this scheme, open-space is categorised three dimensionally; by form,[63] scale, and degree of 'built-upness'. The latter dimension is divided into sub-sets of open space, green space, grey space, and grey/green space. However, because the degree of detail in the topography was not sufficient to make such a distinction, as well as to preserve simplicity in the scheme, the grey/green space category was not used. Instead, the concept of grey/green space was subsumed under green space. Green space is generally defined as any intra-urban land, structure, or geological feature that has vegetation and/or water. This naturally includes spaces such as formal parks and gardens, but also marginal empty lots, pastures, and other 'semi-wild' areas (Stanley *et al.* 2012). Grey space, on the other hand, concerns areas that are paved, hard-surfaced, or more generally bare ground. These spaces tend to have civic uses such as squares/plazas, markets, streets, *etc*.

The dimension of 'form' in the Stanley *et al.* (2012) scheme was also not used, as it required a degree of detail and specificity not attainable from the quality of the topography.

However, the concept from the category of 'incidental space' was appropriated and adapted. In the text, incidental space is defined as

> *"any green or gray space located on the margins of other spaces or buildings that is either ignored or not intended for a specific use other than safety, visual amenity, or physical separation"*

and

> *"are not easily amenable to either formal or functional classification"* (Stanley *et al*. 2012, 1106-1107).

However, the usage of "incidental spaces" in the present study is limited to the spaces between or on the margins of buildings, and excludes the prevalent open space on the inside of the city walls.[64] This category was useful in filling the categorical gap that the moderately sized amorphous depressions between built-up areas created, and provided the advantage of a liminal category that could be either green or grey space. Many of these transcribed voids can be interpreted as empty

63 In this article, the dimension of 'form' also includes types of open space by function. For example, 'streets' and "food production" are both types of open spaces under the dimension of form. The authors note the historical contention in urban studies between the two concepts, and go on to admit that their conflation was intentional, as in many cases the two cannot be divorced from each other (see Section 3.4.4).

64 While this space very well could have been "incidental space", it was also very likely used for agricultural or pastoral purposes, and was therefore placed under the more general "green space" category.

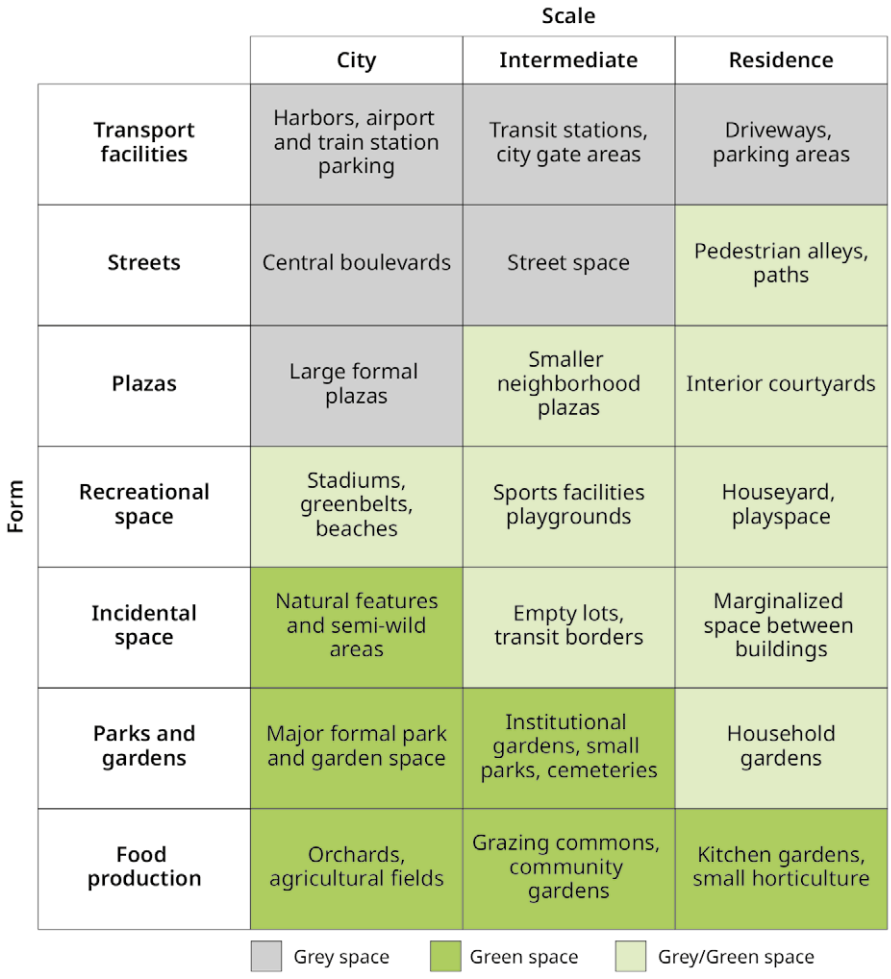

Figure 31. Typology of urban open spaces (after Stanley *et al.* 2012, 1094).

lots in the interior of built-up blocks. Support for this notion is evidenced by the historic descriptions of this kind of space in some of the medieval urban centres in Central Asia, such as Bukhara (Gangler *et al.* 2004).

As with the Stanley *et al.* (2012) scheme, scale was also used as a categorical dimension in this study. However, in this case categorisation of the scale of the transcribed spaces was informed partially by the size of different classes of courtyards in buildings of predominantly Muslim urban settlements. By compiling courtyard sizes and total sizes of structures from different functional classes, distinctions could conceivably be made between separate categories of voids/open-spaces. Extant civic and other public structures from the Umayyad period to the end of the Seljuk period were selected to provide comparative dimensional data (see Appendix II, Table II.2). The civic and public structures included congregational mosques, caravansarais and funduqs, madrasas, and local mosques.[65] Publications were sought out for the preferred manner of attaining dimension. However, upon failure to locate publicised dimensions, the author measured the structures using Google Earth Pro. Due to the

65 The scarcity of extant medieval structures resulted in certain methodological concessions that, admittedly, could impact the specificity of the data. Due to conceivable regional variations in style, ideally only structures from Central Asia and Persianate influenced regions would have been included, but this would have severely impacted the sample size. For the same reason, rural caravanserais were included rather than only urban funduqs, as only a single extant example of the latter could be found. The scarcity also resulted in the classes of 'local mosques' only having one example.

limitations in geo-referenced accuracy in satellite data, and the slightly oblique view of the structures, the measurements are only approximate.

Data of residential courtyards and total house sizes was also included as a class in the compilation. This data was sourced from Kramer (1982), an ethnoarchaeological study focused on the rural Iranian village of Aliabad (see Appendix II, Table II.3). Like the examples used for civic and public structures, the use of this data source had disadvantages as well. Namely, that the recorded domiciles were not medieval and were rural rather than a part of a larger urban settlement, which conceivably could allow courtyard sizes to be much larger than they would have been expected to be in the spatial constraints of a city. However, the geographical setting, accuracy of measurements, and number of examples compensated for the disadvantages.

A total of thirty-nine civic/public structures were recorded: twenty-five congregational mosques, one local mosque, six madrasas, six caravansarais, and one funduq. The data from Kramer (1982) provided sixty-six houses. Unfortunately, the sizes of these samples were not large enough to implement any statistically meaningful operation. For instance, using the total area and courtyard areas as variables, one could conceivably perform a linear regression model to reveal any pattern in the relation between the scales of structures and courtyards sizes. Or, using the structure class and courtyard size as variables, a cluster analysis could be performed to show any possible pattern between the two variables. Any revealed patterns could, in turn, aid in differentiating transcribed voids and their respective functions. Because of the lack of statistical significance, it was necessary to use personal judgment when defining the limits of classes of courtyard sizes in relation to function.

Civic and public courtyard sizes spanned from 14,300 m^2 to 90 m^2, and residential courtyards from 763 m^2 to 13 m^2. There were, however, a few sizable outliers that were removed; namely, the two Abbasid mosques at Samarra, Al-Mutawakkil (14,300 m^2) and Abu Dulaf (14,000 m^2), and households 22/24 (226 m^2) and 79/80 (763 m^2). The transcribed open spaces varied from 10 m^2 to 405,967 m^2, with a total of 647 features. Open spaces were classified in two ways in two separate layer groups in QGIS: one was classified by scale only ('sized-ruled only'), and another that was classified by position, shape, as well as size ('position-ruled').[66]

For both layer groups, four classes were chosen in which to classify the transcribed open spaces, though the schemes would not have a one-to-one correspondence.[67] The size-ruled layer group is comprised of the following layers:[68] 'Urban/spaces', which depicts all the open spaces of the city that were part of the built-up space, such as large squares and incidental spaces, in other words, not large regions of mostly undeveloped land; 'civic/green/incidental', which represents open space categorised as major public areas (civic), green open spaces (gardens, orchards, pasture, *etc.*) or fallow/incidental open areas; 'public/green/incidental', representing open space that could be interpreted as spaces for local public services (in contrast to the city-wide 'civic' classification), smaller green spaces (such as gardens, orchards, *etc.*), or incidental space; and 'private/residential', which is meant to represent features interpreted as open areas that could be categorised as private domestic courtyards.

66 The intention in doing this was to provide more transparency to the positioned ruled layer group, as subjectivity in interpretation was more significant in the identification of the features that comprised the classes, as well as to aid other viewers in reinterpretation.

67 Transcribed features that overlap in separate layers should have the same ID in their Attribute tables across all layers, although some errors may have escaped detection.

68 Descriptions of the layers can also be found on the Metadata tab of their Property windows under the heading 'Abstract'.

The upper limits, or 'bin sizes', of the size-ruled, open space classes were chosen through a combination of inferences based on the data presented in Appendix II, Tables II.2 and II.3, and observations of the transcribed open spaces. The 'urban/spaces' layer upper limit was chosen from observations of an open space (ID no. 63 in the attribute table, 13,959 m^2) surrounding the west side of a large courtyard building (ID no. 34) that is interpreted as at least part of a large public space/square. Within the range of area values, this is also where an apparent 'break' or gap occurred between the given value and the next value, in relation to the yet relatively gradual increase. The layer 'civic/green/incidental' upper limit was chosen with more regard to the data in Appendix II, Table II.2. With the outliers removed from the list of historical civic structures, 8,464 m^2 resulted in the largest courtyard size among the structures measured. While there are values close to this in this layer, a feature with the value of 10,089 (ID no. 404) was chosen as the limit to allow for variance in transcription and for possible sizes of features of this class to be found in this urban context.[69] The lower limit of the class was chosen at 472 m^2. When referring to Appendix II, Table II.2, it can be seen that the lower values of the civic structures varied from around 300 to 600 m^2, with an extreme low value of 140. Most of the values are well above the low values, but as most of the examples are congregational mosques, with other civic and public structures under-represented, a clear distinction between these two classes could not be made. For this reason, there was a large overlap between the layers, with the 'public/green/incidental' layer having an upper limit of 1,789 m^2. The intention in this overlap is that it should allow for interpretive latitude for classes that were compiled from insufficient comparative data. The data for houses was more significant and so a boundary could be decided upon with more confidence between the 'private/residential' layer and 'public/green/incidental' layer. Therefore, an overlap did not seem appropriate. There are quite large values for courtyards in Appendix II, Table II.3, up to 763 m^2, but this is likely due to the rural and less spatially restrictive setting of the village. It seems unlikely that the average city house exceeded ca. 100 m^2 (Hillenbrand 1994). Consequently, the upper limit of a 'private/residential' layer was given at 106 m^2, and a lower limit at 10 m^2, the smallest feature that could be recognised and transcribed, as well as the functional limit of a domestic courtyard. It must also be noted that the former layer was only interpreted through size, as shape is less distinct at smaller scales, and houses are quite ubiquitous across city-scapes.

5.3.4.2 Linear features

Relatively lengthy and straight soil marks, mounds, and rarely wall lines were also transcribed as linear features. While it cannot be affirmed that all of the transcribed linear features can be identified as paths (the preferred term here over 'street' as it is more general and carries fewer implications) – and it is more than likely that some of them are not – there was nothing in the topography that could directly indicate them as belonging solely to a different feature class. All of the linear features, therefore, are conditionally interpreted as paths.[70] As well as paths, all of the linear features were conjointly interpreted as some form of water conduit, and with the same caveats as with the path interpretation. The identification of the

69 Likewise, all of the boundaries of the classes should be considered 'fuzzy' or approximate.

70 As noted before, it was unfortunately not possible to map the convex space of the paths/streets which limited their interpretations and analyses.

Figure 32. Excavation of the Majan Canal showing the brick and ceramic lined water conduits (after Williams 2018, 425 fig. 7).

linear features as water conduits is supported by previous excavations of the Majan Canal, which have revealed opened brick-lined and ceramic pipe-lined sections (Williams 2003; Williams *et al.* 2018) (Fig. 32). Support for paths running parallel to the water conduits is provided by another excavation in the northwest of Sultan Kala (see the 'street trench' layer in the QGIS project), as well as evidence of this form from other Persianate cities (Bonine 1979; 1989).

Chapter 6: Analysis

A number of different analytical methods were employed to address different aspects and scales of urban form and development. All of the methods employed visualisations in plan. The methods for analysing form roughly correlate to separate levels – or a combination thereof – of the hierarchical structure of urban elements within the structure of built form. The hierarchical structure of built form is visualised in figure 33.

In the case of Sultan Kala, the resolution at which the urban form can be analysed is limited, due to the insufficient number of identifiable urban elements. Accordingly, the urban form of the site can only be analysed from the level of Plot Series upwards, comprised of Open Areas and Streets.

For simple visualisation and analysis of the urban tissue, a map was created by 'extracting' the voids[71] from a polygon base in the shape of the intramural area of Sultan Kala. The result was something akin to a Nolli or figure-ground map, and visualises the built-up areas in contrast to the open spaces (see Fig. 34 or the 'built-up area' layer in the QGIS project) as well as spatial networks and linkages. For slightly more advanced analyses, more specific classification of the urban elements/transcribed features was required.

71 While it was noted earlier that paths/streets would be depicted as lines rather than convex space, it was necessary in this case to give a fixed dimension of width to visualise them. A width of 6 metres was chosen for all of the linear features (including linear arrangements and inferred paths), but it must be emphasised that this is only meant for visualisations and not a depiction of their hypothesised width.

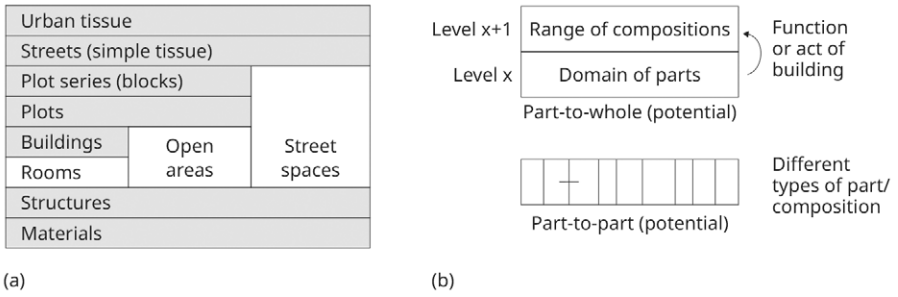

Figure 33. The compositional hierarchy of built form. In section (a), the levels represent increase in complexity of the aggregation of urban elements as one moves up, and an increase in resolution as one moves down. Section (b) illustrates the range of potential parts of the elements (after Kropf 2017, 41 fig. 4.4).

Figure 34. A map of Sultan Kala showing the built-up areas and the voids (Source: image created by the author).

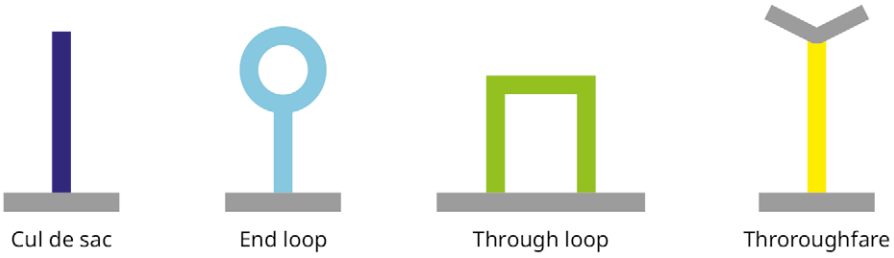

Figure 35. Illustration of the local route types (after Kropf 2017, 83-86 fig. 6.22).

6.1 Routes

As a base layer, all of the layers depicting linear features related to routes (linear features, linear arrangements, and inferred paths) were combined into one layer, 'street/*jub'*. In order to aid the visual analysis, the routes were then ranked and colour-coded in a method outlined in Kropf (2017). The routes were ranked by dissimilarities of access in relation to each other, and then given their own layer with distinct colours. The route types used with corresponding layer names are as follows:

1. **Primary arterial**

Routes that connect different settlements at each end.

2. **Thoroughfare**

Routes that are connected to two other routes.

3. **Through loop**

Routes that connect to the same route on each end.

4. **Cul-de-sac**

Routes that have only one access point/are connected to only one other route at one end.

5. **Cul-de-sac trees**

A sub network of cul-de-sac routes with one access point.

A point layer was also added to illustrate the access points of the routes as *nodes*. It should be noted that this method, although superficially similar to urban route *network analysis*, is not intended to illustrate path choice by agents, degree of traffic, or likelihood of agent interaction. The method presented here is aimed at aiding the identification of distinct zones of the urban fabric that may correspond to different social/functional localities, and/or areas of distinct developmental trajectories.

6.2 Open spaces

As already outlined above, the transcribed open spaces were organised by size/area in one layer group, and by size, position, and shape in another. The latter layer group is comprised of the layers: green space, civic space, grey space, and incidental space. As can be seen, these layers are more specific than the layers in the size-ruled layer group. While the purpose of this layer group is analysis, there was a significant degree of interpretation in its creation. Open spaces were identified based on their position in relation to their location within the urban fabric, the paths, and recognisable structures. For example, large open spaces

(ca. 700-405,000 m^2) that are irregular in shape and located on the periphery of the built-up area/in close proximity to the city walls were interpreted as green space. The layers that depict grey space – that is, spaces that were partially 'built-up' and could be used for public, civic, or commercial uses – were identified by their close association with discernible structures and paths, rectilinear shape, and central position within the urban fabric. The civic space layer is intended to depict open spaces used for civic purposes, meaning space for city-wide use as opposed to local public use. This layer has overlap with the grey space layer, but it is more specific in terms of function of the spaces identified. More emphasis was placed on significant size (575-13,959 m^2) and proximity to discernible structures in their identification. Incidental spaces were primarily identified by their irregular shape and tendency to be distant from thoroughfares.

6.3 Urban fabric and tissues

Referring back to figure 33, it can be seen that urban fabric is composed of all the constituent urban elements below it on the hierarchy. As has been discussed previously, the growth of settlements is accretionary and cumulative, with sections going through periods of varying development intensity and cycles of redevelopment. The urban fabric, therefore, can be considered a palimpsest, as particular urban elements are diachronically conservative, such as streets, plots, and plot series/blocks. Following *Conzenian* morphology and urban analysis, 'reading' the urban fabric through different combinations of urban elements can reveal unique areas called *tissues* or *character areas*. While distinct tissues in the fabric of cities are not merely abstract, the process of identifying tissues is subjective and iterative (Kropf 2017), although the accuracy of transcribed plot series correlating to actual developmental units is dependent on the quantity and quality of available data. Map series (a succession of historical maps of the same settlement) are often relied upon for comparison of urban elements, as well as historical legal documents and field surveys.

Commonly used urban elements in analysis are buildings, open spaces, plots, plot series, and routes, with routes often being used for the starting point for approximate analyses (Kropf 2017). Buildings and plots offer particularly specific and detailed tissues, as plots are often the base unit of periodic development. Unfortunately, in the case of Sultan Kala, as has been observed before, the level of analysis is limited by the available data. Historiographic sources only offer vague relative topographical descriptions, and the resolution of the remains of visible elements only provides plot series/blocks at best, and even these are somewhat visually vague. However, by supplementing the open spaces for plot series and using route structure in tandem as the base elements of analysis, it was possible to partition the urban fabric into distinct proximate tissues, with the caveat that the tissues would be subjective and provisional. In identifying the separate tissues, density and type of routes and open spaces were used as parameters in analysis, with orientation and shape being used as further parameters for routes and open spaces, respectively.

Because plots were not incorporated into the tissue analysis, only streets and city walls necessarily constituted the boundaries between morphological regions, rather than the 'back boundaries' created by the strong association between plots and streets (Kropf 2017). The boundaries between principle morphological regions were demarcated by thick black lines. It is possible, within reason, to split mor-

phological regions into additional, more refined, sub-regions. The sub-regions are characteristically similar to their larger parent region, yet have some further distinguishing attributes. These regions were delimited by a thinner black line. Provisional boundaries – those in which there was less confidence in their transcription – were marked with a dotted line (see Appendix II, Table II.4). To further aid visualisation, the morphological regions were colour-coded, and labelled with alphabetical characters in no particular order.[72]

6.4 Functional and phasal zones

A sixth morphological analytic method was also employed to accompany the methods already discussed above. This method derives from the sector/polycentric model of urban morphology discussed in Section 3.5, as well as incorporating regions of construction phases. Unlike the previous methods, this method drew from the historiographic description of Merv from different periods and, as it is intended to illustrate the topological development of Merv during its Islamic periods, Gyaur Kala is also depicted. Data from excavations was also taken into account when appropriate. The method includes four primary types of functional zones illustrated with separate layers: administrative, religious, commercial, and residential. Other zones/layers illustrate areas or structures whose construction is attributed to a particular governor, or zones that can only be attributed to one period, such as the layer Craft Production. Layers representing functional zones were created for six layer groups which corresponded to six periods:

1. Pre-Islamic period/before 650 CE/29 AH
2. Early Umayyad ca. 650 CE/29 AH -700 CE/81 AH
3. Mid-late Umayyad shift ca. 700 CE/81 AH – 748 CE/130 AH
4. Early Abbasid 748 CE/130 AH – 800 CE/184 AH
5. Late Abbasid – Ghaznevid ca. 800 CE/184 AH – 1037 CE/428 AH
6. Seljuk – Mongol 1037 CE/428 AH – 1221 CE/618 AH

The periods presented here are not intended to solely depict differing ruling regimes, but to illustrate approximate periods of developmental shifts and/or intensities in Merv's history.[73] Unlike the previous methods of transcription and analysis, this method relies more on the overall urban form than the more detailed tissue elements, as it is intended to approximate and hypothesise the locations of different functional/land-use zones.

6.5 Caveats

This section will provide a generalised outline of the results of the transcription/mapping and its implications. For detailed tables of attributes of the feature layers,

72 It is worth clarifying that the morphological region/tissues are not meant to convey distinct urban areas as they would have been perceived by the residents of the city, such as with neighbourhoods or quarters, but rather the differences in urban fabric that may signify areas of different developmental trajectories as previously stated. Although there is the possibility of some degree of correspondence between the transcribed morphological regions and the perceived districts of the city, it would be difficult to verify this.

73 The reader might find it useful to refer to the timeline presented in figure 3 when viewing the phase layers.

the reader should refer to the QGIS project, as displaying the lengthy lists here would be impractical.

The process of transcription resulted in two types of layers from an analytical perspective: layers that are more qualitative in their use, and those that also provide quantitative information. Of the latter group, the principal layers are those concerning linear features and open spaces, with the rest of the layers pertaining to the former group. Many of the qualitative 'results' should be viewed and explored by the reader in the QGIS project, and do not warrant verbal illustration in this section. An appraisal of the results, however, will be provided.

There are two caveats concerning accuracy related to the two types of resultant data that need to be addressed: accuracy in identification and missing data. With certainty, errors have occurred in both these facets in the process of mapping the urban landscape. The main sources of accuracy errors in this study are the features presented as open spaces and, to a lesser severity, the linear features. Missing data is the bane of traditional archaeology, as the ability to acquire significant samples can be limited by the contextual and physical bounds of the methodology, as well as the possible ambiguous nature of the sample(s). The situation is not significantly different in this work with the use of AP as the samples. To illustrate this, it is likely that some of the 'open spaces' were misidentified, especially concerning the smaller scale household spaces, as the properties used to identify them could also be shared with other archaeological or natural features, e.g., although less likely, a small vegetated depression could signify a room, or be the result of natural erosion. Additionally, courtyards could have simply been overlooked or, more likely, undetected because they are subsurface and undetectable with the methods used. This conclusion is highly supported by the dearth of transcribed residential sized courtyard spaces in contrast to the far more numerous figure one would expect from a city the size of Sultan Kala.[74]

To a lesser degree, the situation was similar with the identified linear features. Although it was easier to individuate linear features and more confidently identify them as streets/routes, there is still the possibility here of misidentification and undetected features. As with the residential courtyards, there appeared to be a possible lack of smaller secondary and private alleys. Seemingly, the internal spaces of some of the larger plot series/blocks could not have been accessed via the thoroughfares and cul-de-sacs[75] suggesting that some alleys missed detection. However, with the greater simplicity of visually recognised patterning and thus ease in detection and greater confidence in identification, there is more certainty in accuracy in this class of features compared with the open spaces.

Given the caveats concerning missing data and accuracy, and in order to proceed in making more significant analyses and interpretations, it must be supposed that the transcribed features and maps present samples that are representative and at least broadly accurate of the general topographic patterns of the city-

74 To make a simple comparison to the rural village that Aliabad cited for estimated courtyard size, 67 courtyard houses (not including the 'households' recorded in the original table) were recorded for a village size of 3 hectares (Kramer 1982, 115 and 160). This contrasts with 243 residential courtyards that were recorded and identified for roughly 600 hectares (simplified as 81:200), or roughly 345 hectares if only the *shahristan* is counted. Even accounting that the comparison is made between a village and a city, the ratio of the number of household courtyards for the size of Sultan Kala seems highly awry.

75 Admittedly, the degree to which this is the case is undetermined. The building density of medieval cities in this region is not accurately known, but the conclusions presented by Soboti (2005) of physically expansive suburbanisation of cities in early medieval Central Asia, coupled with the likely presence of large incidental lots and green space, indicate that the density of Sultan Kala was not particularly high.

scape. Along similar lines, the more generalised the maps and transcribed feature layers, the more confidence in the accuracy that they can be attributed since they offer less detail and thus fewer predictions that might turn out to be false. This invokes the legitimate concern that generalised visual representation might convey information in a manner that is so broad as to be of little value. However, this concern should not be overvalued, as generalised visualisation is the most intuitive way of conveying spatial data. Additionally, the generalised maps can be coupled/overlayed by the more specific transcription, increasing their interpretive value. For instance, the 'built-up area' layer was a product/result of the difference between a solid polygon layer in the shape of Sultan Kala, and the open spaces and linear features layer, which generated a map depicting the 'built-up' areas of the cityscape. Though it derives from layers that likely have errors and missing data, this map lacks highly specific classes of features and instead depicts the data in a general manner which facilitates visualisation and comprehension.

In summary, it is acknowledged that at least some of the transcribed data will inevitably be erroneous, but it should also not be dismissed as specious and without use. There is a fair probability that the transcribed data depicts – at least broadly – substantive patterns of the urban topography from which interpretations, conclusions, and further hypotheses can be formed.

Chapter 7: Discussion

7.1 The topography of Sultan Kala: Its development and evolution

The topography of Sultan Kala – both actual and depicted transcription – essentially expresses the state that the city was in around the time of the Mongol sack. It can be assumed that palimpsests of successive periods of development imprinted themselves in the urban tissue, a process common to all urban settlements, as discussed in Chapter 3. However, because of the absence of detailed textual and cartographic resources used in morphological analyses of modern cities, coupled with the ambiguity of the archaeological topography, an analytical discussion of the topological development of the city cannot proceed neatly in one diachronic direction. Rather, like the process of the physical topographic analysis, a discussion such as this must be somewhat iterative and topical.

7.1.1 Spatial 'determinants'

A study of urban topography must necessarily begin with the influences of spatial relations, namely *first* and *second order effects*, and human-made influences. For the purposes here, *first-order effects* are essentially synonymous with the variations in the natural topography.

The urban settlements of Merv developed on a relatively flat plane, and so the natural topography has not restricted the patterns of settlement growth and

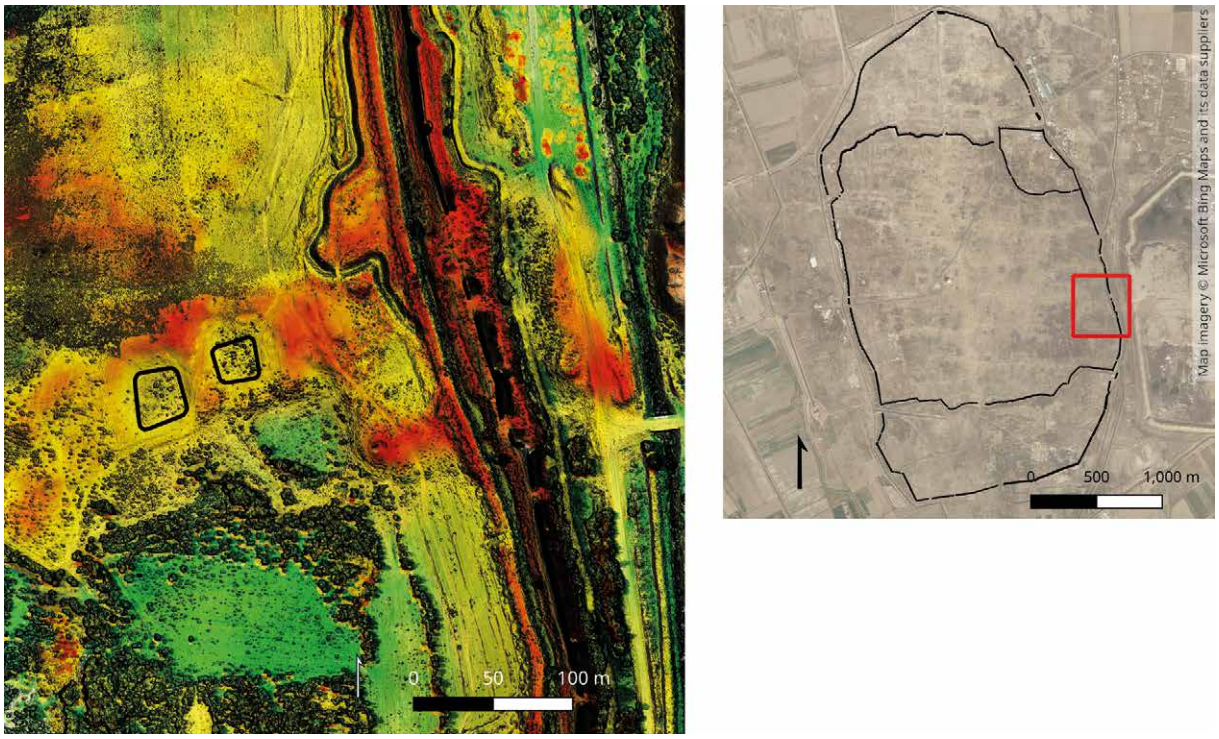

Figure 36. DEM and RGB blended layers depicting the double 'courtyard' feature (just left of centre) (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

morphology to the contours of the land. Rather, the naturally flat topography has allowed for *second order effects* – here meaning the spatial variation caused by interaction between humans – to have more influence on the form of development.

More influential than the topography, the next most basic spatial determinant in the Merv Oasis is the canal system that supplied the urban centres and agricultural fields with water. Sourced from the Mughab River, there were four principal canals (referred to by Istakhri and Yaqut as "rivers") that ran northward through the oasis: the Asadr Khurasani to the east of Gyaur Kala, the Razik between Gyaur Kala and Sultan Kala, the Majan which runs through the centre of Sultan Kala, and the Hormuzfarra to the west of Sultan Kala (Fig. 1). These canals are ancient in their origin and so they were present at the time of the Arab/Islamic conquest (Williams 2018a; Herrmann 1999). While they are human-made, the natural topography and variations in the ground likely influenced their meandering pattern, and have even been suggested to have been modified natural rivulets (Bader *et al.* 1994).

It is probable that the placement of the old cities of Merv, Erk Kala and Gyaur Kala was likely chosen to benefit from the proximity of the flanking canals. While it is clear that the final form of Sultan Kala that likely arose during the Seljuk period was centred on the Majan, it is apparent that Gyaur Kala itself and the Razik Canal were attractors for its suburban development.[76] It is known from Istakhri's account that there was a suburb with the "Old Mosque" just outside the *Bab al-Madina* gate of Gyaur Kala on the banks of the Razik. A possible candidate for the "Old Mosque"

76 An influx of Arab settlers and rural *dihqans* and peasants newly attracted to cities after the establishment of the centralised form of Umayyad governing (Soboti 2005) may have stimulated the development of this suburb.

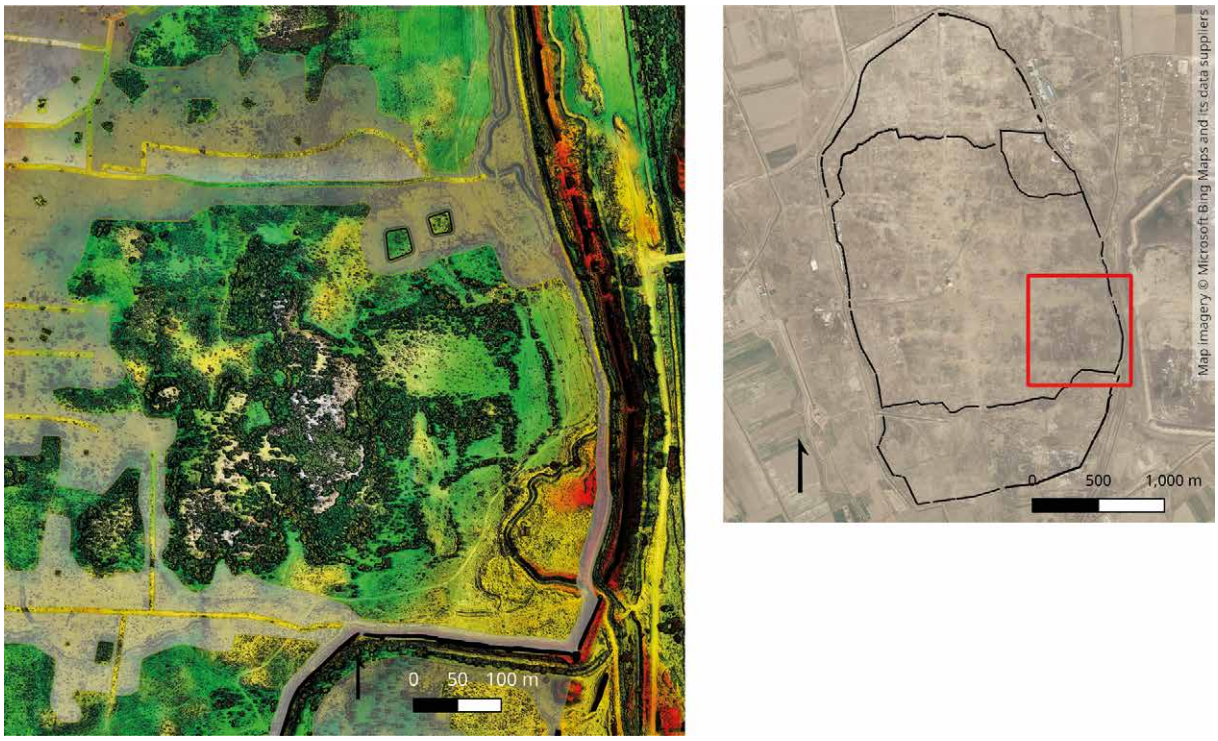

Figure 37. Another DEM and RGB bend depicting the highly vegetated basin/pool (centre) with the double 'courtyard' structure at its perimeter (upper centre-right) (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

is the double 'courtyard' feature that is just south of the Sarakhs road, although the features are curiously misaligned (Fig. 36).

Initially a suburb of Gyaur Kala, this suburb grew into a quarter of Sultan Kala, and likely had a significant effect on the development and form of the city as it grew. However, there is no overt indication of the area near the gate or along the Razik being heavily developed from looking solely at the urban topography. Most of the recognisable remains of the built-up area appear to be along the Sarakhs road that bisects Sultan Kala from east to west. Much of the land near to the Razik/the eastern wall of Sultan Kala appears to have been green space, especially in the southeast of the inner walled city where there also seems to have been a shallow pool (Fig. 37). Archaeological evidence does support that there was sustained occupation – if not significant development – of this area, as cited in an unpublished Soviet era undergraduate dissertation of a sondage in a house that was located close to the city wall in the southeast corner (Krikis 1958).

As it appears as the central 'spine' of the latest stage of Sultan Kala, it is readily apparent that the Majan became the prime attractor for urban development in the area. It cannot be overstressed that the Majan had a major influence on the spatial patterns of the city's urban elements.

Figure 38. ***Jub*** **and** ***khort*** **agricultural fields along Sultan Kala's southern wall in 2014 (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).**

7.1.2 Spatial patterns and development of urban elements and tissues

7.1.2.1 Irrigation and route networks

Although providing water to the urban settlements, the primary purpose of the canals of the Murghab Delta was likely agricultural, similar to modern canals today. One of the most notable patterns of Sultan Kala is the interlacing of the intramural linear features. This patterning of mostly east-west and north-south oriented lines strikingly bears the characteristics of *jubs* found in the irrigated agricultural field, which generated urban morphologies of Iranian cultural areas described by Bonine (1979; 1989) and Kheirabadi (2000) as discussed here in Chapter 4. The initial age of the *jub* system along the Majan can only be hypothesised to be sometime between the beginning of Umayyad rule to around the beginning of Abbasid rule when agriculture in the region was thriving (Simpson 2014). Additionally, the placement of the *Jami – Dar al-Imara* complex highly suggests that the Majan was flowing at the time of construction. However, this form of field irrigation at Merv was most probably initiated by local inhabitants, as this fits with the pattern seen in other urban centres of the region and is not known to be a pattern of irrigation in Arab regions.[77]

In *Kitab Al-Masalik Wa Al-Mamalik,* Istakhri notes how each quarter and street of Merv were watered by the "little rivers", but from the map it can be seen that the main irrigation conduits and *jubs* clearly have an uneven distribution. This

77 Although not considered a part of the Persian sphere of influence today, this pattern of field irrigation is still used with small-scale agriculture practices in the Merv Oasis (Fig. 38).

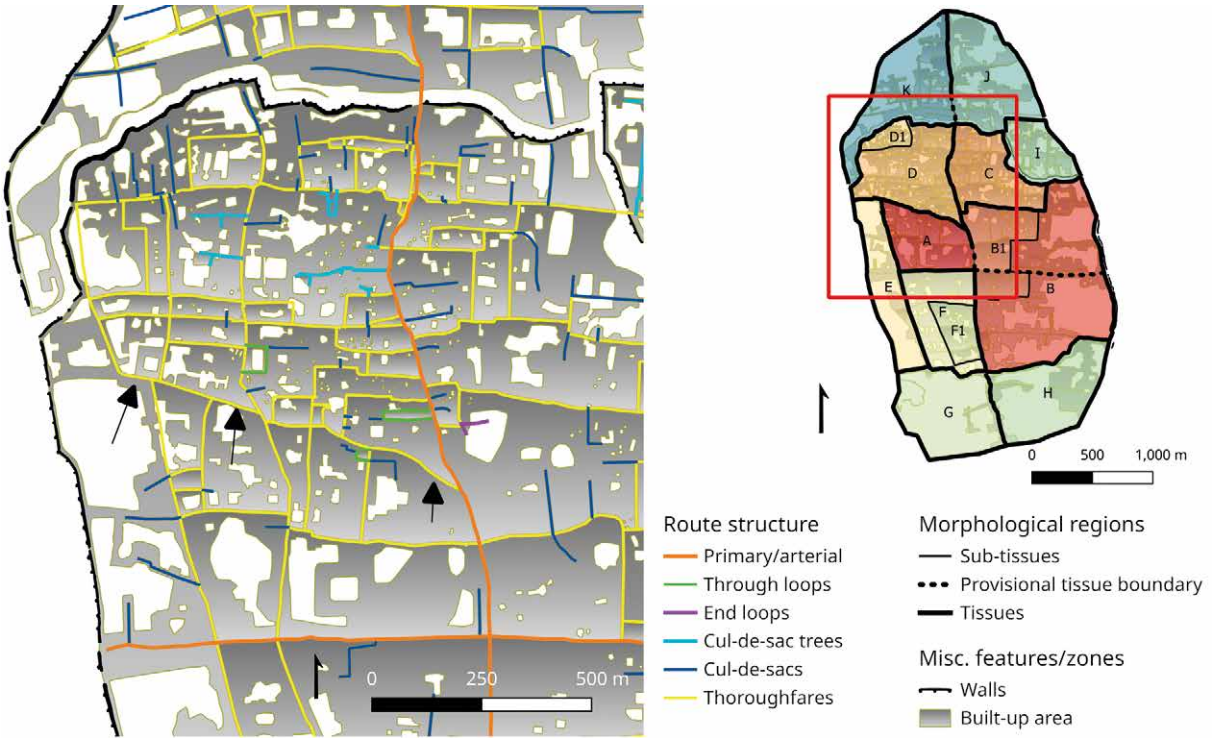

Figure 39. Overview map illustrating the morphological regions, and a detail map showing the route structure. Note the arrows indicating the *jub*/route that branches off from the Majan Canal and creates the boundary between regions 'A' and 'D' (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

may help reveal the spatial development of Sultan Kala. The northwestern area of the *shahristan*, the area that corresponds to morphological region *D*, displays a particularly high density of the presumed *jubs*. This is likely due to the presence of more feeder conduits. The two longitudinal conduits in addition to the oblique conduit that branches from the Majan to the north-west likely abundantly supplied this delta-shaped area with water, making it an advantageous area for agriculture and later residential purposes when the fields were infilled with buildings and the *jubs* lined with streets (Fig. 39).

Indeed, the whole eastern half of the city seems to lack significant north-south oriented conduits and exhibits mostly lateral conduits branching off from the Majan, and short longitudinal ones connecting these. While these lateral *jubs* presumably provided water to residents, they also likely provided drainage for waste water and overflow at times when the Mughab and Majan were flooded. Drainage would have flowed into the moats as well as pools at the margins of the densely built-up areas. This is probably why there is a prevalence of green space in the west (area *E*) and in the southeast (area *B*). It is evident that the oblique conduit branching from the Majan forming the border of region *D* had a significant effect on the morphology of this quarter, especially to the north. It likely had an influencing relation to the adjacent *Byash Barmak köshk* (feature no. 30 in Major structural features) and later the large courtyard structure (feature no. 32)[78] and may be considered an early construction that also influenced the placement of the *Jami – Dar al-Imara* complex.

78 For the numbered features, see the OpenData Portal of Kiel University under: https://doi.org/10.57892/100-322.

Figure 40. Map showing how some linear features are aligned with the city walls (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

In the southern *rabad* (regions *G* and *H*), there is a very sparse pattern of conduits and very little in the way of recognisable built topography. This may suggest that the *rabad* was sparsely populated when the city was inhabited, but this conclusion is questionable due to the clearly disturbed quality of the area. This is evidenced by the presence of the modern rectilinear canal, the agricultural fields, and the cemetery. However, there are yet visible remains, the most obvious being the well-preserved Askhab Mausoleum (likely Seljuk but rebuilt in the Timurid period) and the adjacent *sardoba* roughly in the centre of region *H*. Additionally, the terrain flanking the Majan has a high relief, suggestive of some previous developments, and a number of geometric mounds can be seen in area *G* (Major structural features 3-13) and area *H* (features 14-17). The corner positions of features 5 and 16, and the gate adjacent position of features 10-13 may indicate defensive purposes. The disturbed nature of the southern *rabad* makes its character difficult to decipher. In contrast, the northern *rabad* – referred to as *Iskander Kala* and pertaining to morphological regions *K* and *J* – appears to have a more visible topography. The large amount of green space and fewer moderately-sized incidental spaces suggest that this area was less densely built-up than the *shahristan* and likely developed later.

Some conduits appear to be aligned on either side of the northern and southern *shahristan* walls, which indicates that, at least at some point, they were the continuation of the same conduits and were constructed before the walls (Fig. 40). This may also imply that these conduits, two of which run nearly the entire length of Sultan Kala, were dug before any significant urban development arose in the area, as this would presumably have impeded their construction. While there are two such conduits on the northeastern half of the city, between regions *C* and *J*, they merely connect two lateral conduits of the Majan; the absence of lengthy lateral conduits

Figure 41. The ruins of what has been interpreted as an elite residence. The surrounding area up to the meandering rivulet has been interpreted as green/open-space (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

in the east of Sultan Kala, then, may signify that the area adjacent to the Razik was indeed initially developed. It cannot be undoubtedly ascertained if these conduits continued flowing through without interruption after the wall was constructed, or if they were disconnected to flow into the moat.

Regardless, they would have still received a flow of water, as it is known from excavation that the Majan continued, covered through the Kushmeihan gate in the north wall and under the moat (Williams *et al.* 2018), which also suggests that they too continued their northward flow. The construction of the wall would have, however, certainly interrupted the probable adjacent streets. The water conduit/route systems projected how it would have been constructed, and the observed systems are depicted in the layers 'network prewall' and 'network', respectively. The wall and the bisecting of the streets would have drastically changed the developmental trajectory of Sultan Kala. Without the impediment of a wall, the ease of traversing between these two regions would have facilitated northward development. The wall restricting movement through the gate would have made amenities in the more developed *shahristan* more difficult to reach, thus making the northern *rabad* less desirable and slowing development. A similar situation would have occurred for the southern *rabad* but, as has been noted, it is more difficult to come to a confident assessment for this region.

7.1.2.2 Open spaces and other features

As with the spatial distribution and orientation of the linear features, the spatial distribution of the open spaces and significant features may help to understand the spatial and temporal development of Sultan Kala. Highly conspicuous are the large open green spaces adjacent to the city walls to the east and west of the *shahristan*, and on the margins of the north *rabad* (the unexpected situation of the

Figure 42. Location of Byash Barmak köshk adjacent to possible green-space and pools (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

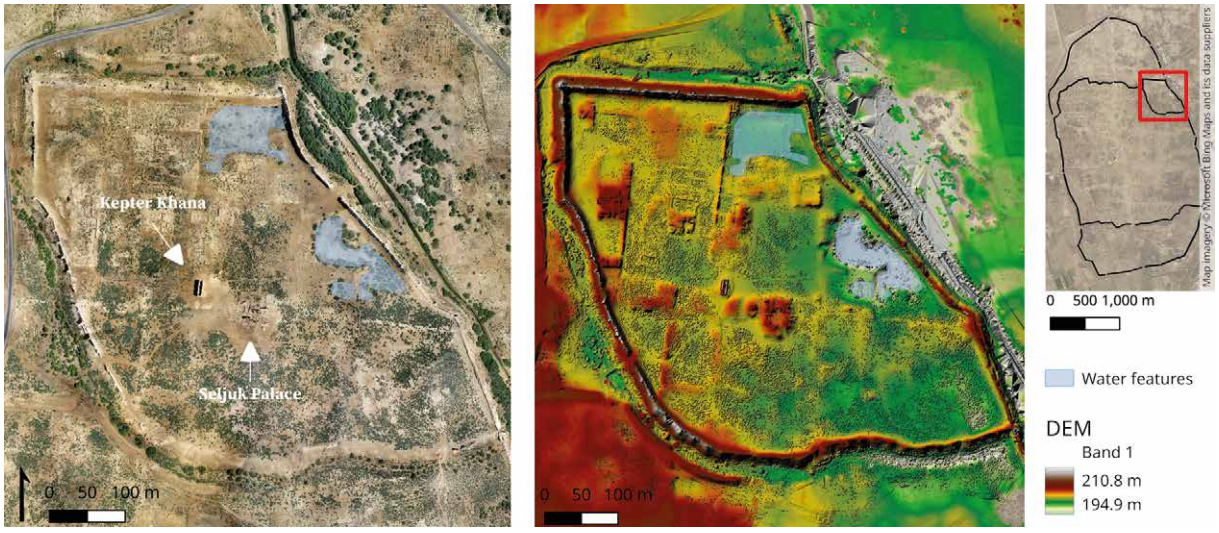

Figure 43. Possible area for drainage (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

southern *rabad* has already been addressed above). Water conduits and *jubs* can be seen leading to and terminating in these large open spaces. In regions *E* and *B*, there are large flat basins with vegetated outlines which suggest these were pools or large reservoirs. The presence of rivulets and what has been interpreted as an elite house near the southern city wall in region *B* may signify that at least part of the green space in this area was a garden or an orchard (Fig. 41). A similar provisional conclusion can be made for the western corner of region *D* and the

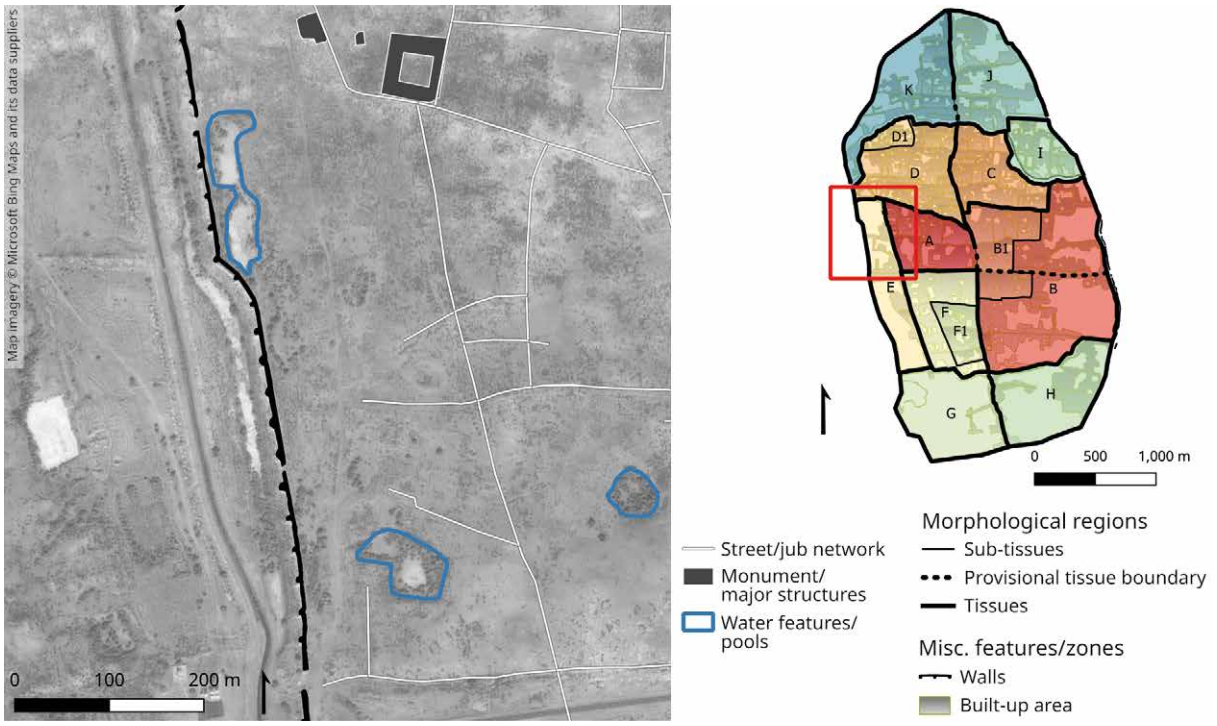

Figure 44. RGB and DEM showing where the pools and surrounding gardens would have been with Shahryar Ark (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

northern area of region *E*, given the presence of *Byash Barmak köshk* (Fig. 42). Suggestive of the regions being comprised of at least some garden/orchard area is the presence of pooling in the *Shahryar Ark* (Fig. 43), an area where there were almost certainly gardens used by the ruling elite. The northern area of region *E* has been disturbed by vehicles, and so the topography is less clear, but the absence of an elite structure along with the bifurcating large furrows prompts an interpretation of this area as being drainage and overflow more than a garden area (Fig. 44). Smaller non-marginal pools and reservoirs also likely existed, some of which can be tentatively identified by the *jubs* which appear to terminate in open spaces, but these spaces to not display the conspicuous soil properties suggestive of pooling that is seen in the other areas.

As outlined in Chapter 4, in addition to the large pools and reservoirs, traditional Iranian cities possessed smaller semi-subterranean water storage facilities called *sardobas*. Like the extant one in the southern *rabad* of Sultan Kala, *sardobas* have a distinctive round form to their architecture, and so possible remains may be identified by this characteristic and the proximity of a water source, namely a *jub*. Indeed, seven possible *sardobas* have been identified as illustrated in the layer 'circular water storage/*sardobas*'. Notably, all of these features are adjacent to a *jub*, with four of them adjacent to the Majan. It can be inferred from this that water was either more preferred when sourced from the Majan directly, possibly for sanitary reasons, or water storage was prioritised over other uses, or both.

The distribution of observable residential courtyards may indicate a preference for the close proximity of certain water sources, particularly the Majan. Clustering of residential courtyards can be seen close to the Majan and along nearby subsidiary *jubs* in morphological regions *C, D, F1,* and *B* (Fig. 45). Clustering also occurs near the large open spaces in the east of the *shahristan,* in regions *B1* and

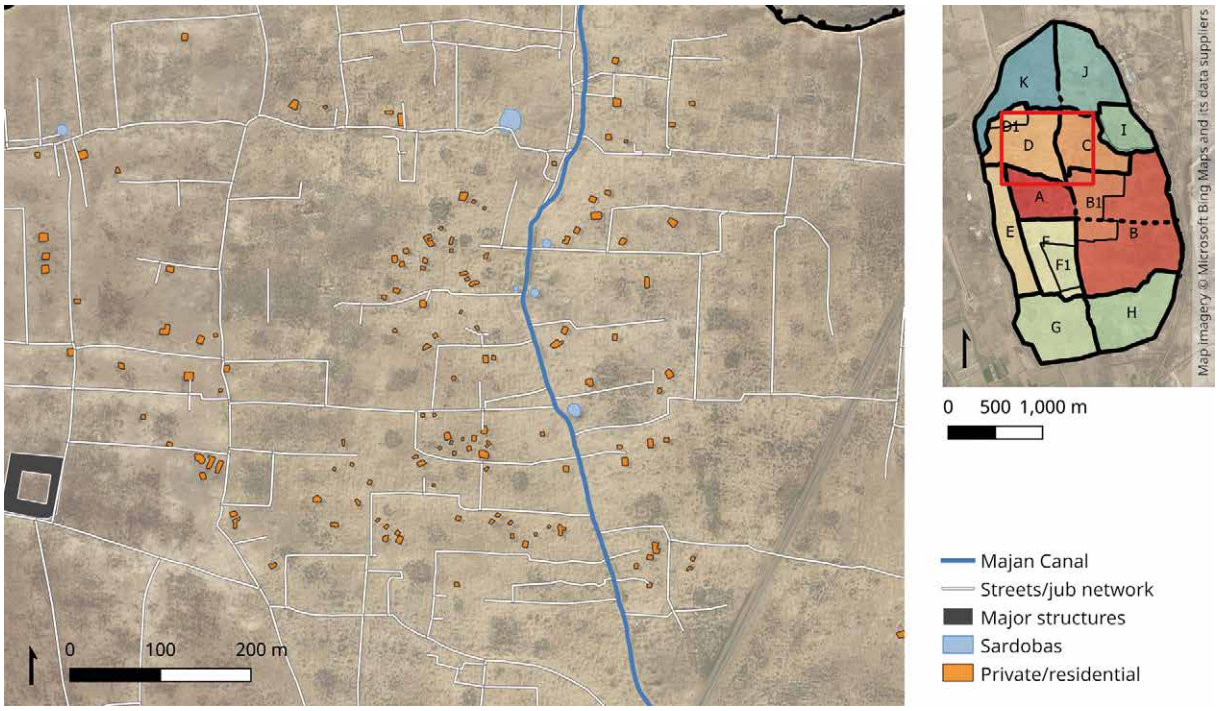

Figure 45. Map showing an example of the apparent clustering of house-sized courtyards along the Majan Canal (Source: Both images were created by the author after photos from G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

B, an area that may have been supplied by the Razik. It is reasonable to consider that there was a component of social stratification/class in this distribution, but testing this hypothesis would require thorough excavation data. Additionally, the dearth of identifiable residential courtyards further away from primary sources of water would need to be explained.

7.1.3 The forms of medieval Merv

As noted above, the topography of the latest expression of Sultan Kala does not, on its own, reveal a great deal about its previous developmental forms. It is necessary to draw from the body of knowledge on Islamic urbanism and historiographic geography accounts of Merv to map out the development of the topography and forms of the city. To re-emphasise, the use of the term 'form' in the context of urbanism is meant to convey the entire composite of urban elements and tissues. To be demonstrated below, Merv underwent a series of 'formal' periods. These phases are visualised under the layer group 'phases', and are organised into different periods which are in their respective sub-group layers. Drawing on multi-centric urban theory, the topography and form in this model are comprised of different areas of land-use, as well as areas of construction commissioned by ruling governors. The areas should only be considered as approximate and, in some cases, hypothesised. The date ranges for the periods are also approximate, as the periods are meant more to demonstrate their relative sequencing.

Although Shaim Kala may have been the initial post-conquest settlement, a discussion of the forms of medieval Merv must begin with Gyaur Kala, as only indirect conjectures can be made about its form due to the lack of physical evidence, and there is nothing to indicate that it had any influence on the forms

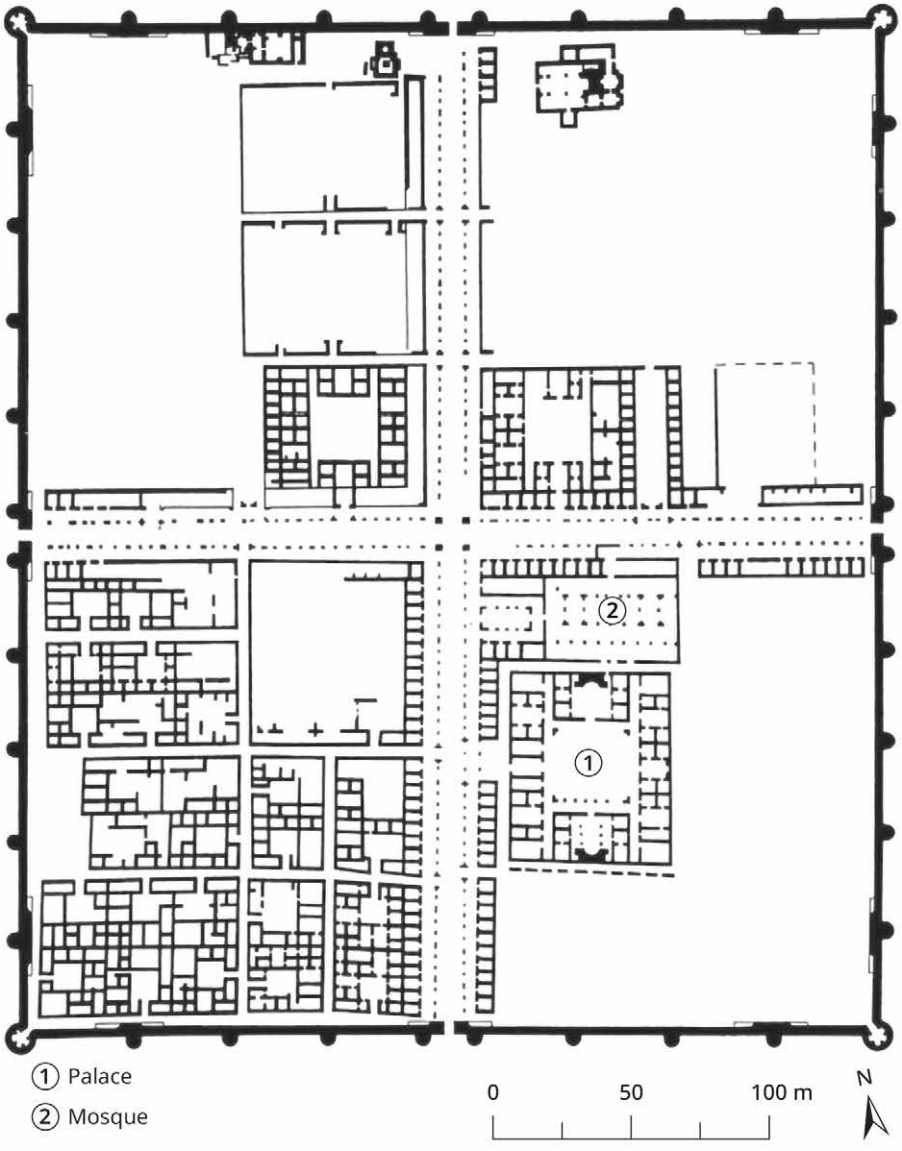

Figure 46. The form of Umayyad Anjar and the location of the palace (1) and the mosque (2) (after Northedge 2017, 160).

of later developments. Having occupied Gyaur Kala, the Umayyads imposed their idea of 'city' onto the settlement. They constructed the first mosque and the initial *Dar al-Imara* in the centre of the city at the crossing of the two main streets.

Although the citadel, Erk Kala, is initially occupied, as an administrative and palatial structure it is abandoned for the newly constructed civic centre (Herrmann 1999). This pattern reflects the form of Umayyad founded cities such as Anjar and Ramla, and the construction of these caliphal structures at the centre of an already dense city must have been a demanding yet decidedly symbolic act (Fig. 46).

After a period of time in which the Umayyad administration and Arab settlers had established themselves in the Merv region, the *rabad* outside the west gate of Gyaur Kala began to form. This area might have had some settlement before this phase, but the increased population likely caused this area to develop more intensely in a process of suburbanisation seen in other cities of Central Asia during this period (Sobti 2005). It is during this period of suburbanisation, too, that the

cultural and civic 'centre' of the city began to shift to the *rabad*, as suggested by the second or "Old Mosque" and the markets that were reputed to have been located there. There is no direct or second-hand evidence that the area around the intersection of the Sarakhs road and the Majan developed a suburban settlement at this time, but there are sensible reasons to consider it a likely possibility that there was such a development. The intersection of the Majan and the Sarakhs road would have made it a desirable location for commerce, as well as agriculture due to the nearby branching of the Majan. Perhaps the most convincing indication that this location was also settled is that it was chosen for the site of the *Jami – Dar al-Imara* complex and the new markets, as presumably erecting these caliphal structures would not have as much symbolic impact and be as integrated in the city if the area was mostly empty.

Regardless of the settlement status of the Majan district before the construction of the *Jami – Dar al-Imara* complex and the move of the markets, these venues were undoubtedly attractors for further settlement and development in that area. This scenario resulted in the Majan suburb progressively becoming the administrative and commercial centre of the city, another aspect of the process of suburbanisation seen in the cities of Central Asia between the seventh and tenth centuries (Sobti 2005). In most of the other cities in which this process occurred, the result in form was simply a larger city from an attached section of growth, with the new suburb either becoming an additional public/civic centre, or the centre having shifted thereto. In the case of Merv, the suburb replaced the former *shahristan*, as the latter gradually declined due to a draw by the former. This particular process is evidently what also happened with Samarkand, as the ancient summit of Afrasiab was eventually abandoned (Gangler *et al.* 2004). The irregularity of these cases within the wider process of the region and time evokes the question why Merv did not undergo a process of expansion or something similar to conurbation with the Majan suburb, and instead developed into the separate urban centre Sultan Kala.

Naturally, this process was gradual, occurring over the period of about 400 years from the founding of the new civic centre by Abu Muslim ca. 748, and concluding during the Seljuk period (ca. mid-12th century). The process was also, very likely, not regular and the Majan suburb probably experienced periods of development and Gyaur Kala of decline. Unfortunately, from around the end of Abbasid rule in Merv in the early 9th century to the middle of the 10th century, the developmental progress of the city is fairly obscure, as there are not any historiographic sources during this time from which to draw, and the archaeological work was not extensive enough to make any confident conclusions. It is only around the middle of the 9th century and at the beginning of the 10th century that there are accounts from Istakhri[79]and Muqaddasi[80] that tell something about the city's condition. The two accounts are similar, in that they both mention the Majan and Razik suburbs, and identify Gyaur Kala with its four gates and a *quhandiz* as the

79 "There is also the River Majan on which are found the Government House, the new Friday mosque and the prison [...]. There is also the River al-Razik which flows by the city gate [...]. The inner city has four gates. These are the Bab al-Madina on the side of the Friday mosque, the gate called the Bab Sanjan, the gate called Bab al-Layn and Bab Dur Mishkan" (Istakhri, transl. by Kennedy 1999 in Hermann 1999).

80 "Marw is on a plain far from the mountains. The old central city is on a hill, in the middle of which is a place of prayer which used to be the Friday mosque formerly; there are many houses around it. At the gate of the suburbs are buildings and a small market, and in the suburbs are two mosques: one at the gate of the inner city, the other in the money exchange [...]. The inner city has four gates – Bab al-Madina beside the mosque; Bab Sanjan in the other direction; Bab Balin; Bab Darmashkan, beside which stood the palace of al-Ma'mun. The quhandiz is in the inner city" (Herrmann 1999, 124-125).

madina or inner city. What can be inferred from this is that Gyaur Kala was likely still occupied to a significant enough degree at this time in which to warrant that designation. Another possibility is that Gyaur Kala was considered the inner city because it was the walled section of the settlement.[81] Muqaddasi also mentions that there are many abandoned and ruinous buildings in both the inner city and the suburbs,[82] possibly indicating that this was not a particularly prosperous time and therefore not a time of intense development – for Merv.

Apart from possibly[83] the large structure roughly in the centre of Sultan Kala, any features and palimpsests from this dual centre phase of Merv are imperceptible. Features and micro-topography within Gyaur Kala are indistinct compared to Sultan Kala, which although not revealing much about its urban tissue, may indicate its less recent occupation and dwindling development. Moreover, as noted before, there is no discernible topographical indication of the market suburb developing just outside the western gate Bab al-Madina of Gyaur Kala. Instead, dense topography is more visible along the Majan. Possible explanations for this may be that the construction of the later wall for Sultan Kala razed many structures, or that the area simply never developed intensely enough to produce much artificial topography.

The next major phase of Merv pertains to the Seljuk period and thereafter until its sacking by the Mongols. Like the Early Abbasid period, the Seljuk period was prosperous for Merv and it experienced extensive development, especially under the rule of Sanjar. It is during this period that Merv likely acquired one of the possible most discernible features of its form; its first city wall. The wall's construction is attributed to Malik Shah (1072 CE/465 AH-1092 CE/485 AH), but was supposedly destroyed shortly thereafter by Arslan Arghun in 1095 CE/488 AH. The wall that remains today exhibits two distinct phases: an inner "hollow" phase with rooms and corridors and is attributed to being the first wall of Sultan Kala, and an outer phase which reinforced the inner phase by filling the voids and applying added layers of mud brick to the facade. Being hollow and measuring eight meters in height, it has been noted that the initial wall was likely only intended for minor defence rather than serious attacks (Herrmann 1999; Herrmann *et al.* 2000), though it is possible that walling the city had a significant symbolic element to it, as walls may have slowly become considered a feature associated with 'city-ness'. Through examination of ceramic samples, the estimated date of the second phase is shortly before the sack by the Mongols (Herrmann 1999), which would explain the reason for reinforcing the walls against more serious attacks. The first wall, which would not have yet included the northern and southern suburbs and possibly not the citadel Shahryar Ark, approximately mirrors Gyaur Kala in size and shape, as it is roughly square in plan.

The outline of the walls offers some insight into the developmental status of the city around the time of the wall's construction. The east and west walls appear with some sections of slight curvature and others that are linear. In contrast, the southern and especially the northern walls are highly irregular, signifying that

81 Muqaddasi does mention that the suburbs had a gate, and Herrmann (1999, 122-124, transl. by H. Kennedy) in his account of Merv lauds the "divisions of its buildings and quarters". From these passages, one could reasonably infer that the quarters/suburbs were also walled, and thereby seemingly weakening this argument. However, walls separating districts were likely considered a different quality to outer city walls.

82 "Marw is a notable town but its population is small, for it has gone to ruin except for a few houses; a third of the suburbs are laid waste as if it dated from antiquity" (Herrmann 1999, 124-125). Concerning this passage, Kennedy (1999, 34) warns the reader "not all al-Muqaddasi's negative rhetoric should be taken at face value". Indeed, Muqaddasi does seem incongruous in his description of Merv, as earlier in the passage he describes it as a "capital delightful, fine, elegant. It is brilliant, extensive, pleasant."

83 The age of this feature has not yet been determined.

there was intention to include or exclude some features/structures either within or outside of the city walls (Fig. 40 and Fig. 1). In some areas, however, excavation has evidenced that the decision was made to partially raze structures to clear a path for the construction of the wall, as is the case at the northern gate to Iskander Kala where the foundations of a previous caravanserai had been found (Williams 2018b). The dissimilarities in contour between the eastern/western walls and the northern/southern walls indicate different urban density or degrees to which the two areas were built-up; the areas in the east and west of the city had relatively low density. In contrast, the northern and southern areas were dense. This pattern was likely due to the centripetal attraction of the Majan Canal. The choice in placement of the wall, however, is puzzling and warrants examination. On the one hand, the rationale for the outward placement of the eastern and western walls is not difficult to understand. Constructing the wall beyond the limits of the densely built-up area (see the border between morphological region *A* and *E* for instance) would provide room for future urban growth, while also providing open green spaces and the use of the drainage pools on the margins of the city. On the other hand, placement of the wall in the north and south of the city through built-up areas rather than encompassing them is perplexing. Unfortunately, no satisfying assumption can be made here.[84] Whatever the motivation behind the walls' orientation, it would have affected the development and growth of the city. As noted already above, the restricted access between the central city and the northern/southern suburbs would have presumably retarded their development, although they apparently continued to grow, particularly in the northwest, as is evidenced by the built-up topography.

The northern and southern suburban extensions to Sultan Kala were ostensibly considered significant enough to enclose them in walls. Construction of the suburb walls, as well as the citadel are attributed to Sultan Sanjar (Herrmann 1999), and it is the period of his rule to which the final formal sub-phase of Sultan Kala can be ascribed. Sanjar is regarded to have had a proclivity for building (Adle *et al.* 2003), and as he made Merv his capital, it is likely that he commissioned the building of numerous significant constructions, but the only visible ones that can be ascribed to him with any degree of certainty are the northern and southern suburb walls and the citadel. These features are what provide the dominant final form of Sultan Kala that can be seen today, although the city would be occupied for another sixty-four years until the Mongol sack, with likely some minor re-occupation thereafter (Fig. 47). While enclosing the northern and southern suburban developments within the city walls would have offered these areas some protection against outside threats, the construction of the citadel would have changed the way the city functioned significantly in addition to providing protection to the sultan and administrative institutions.

As with the inner city walls, the citadel would too have a moat outside the perimeter of its walls.

The contour of the citadel walls suggests that there was a preference for linearity in its construction, as the outer walls are fairly straight, particularly the northwest corner where there is a right angle. Conversely, the inner walls to the southwest are irregular. This could indicate that the areas around the northern and eastern sections of the citadel were sparsely built-up prior to the citadel's construction and therefore provided less obstruction to the orientation and path of the planned

84 It can be speculated that the choice in the shape of the walls intentionally resembled the shape of Gyaur Kala in deference to the old city, but this conjecture can likely not be proven and so has limited value.

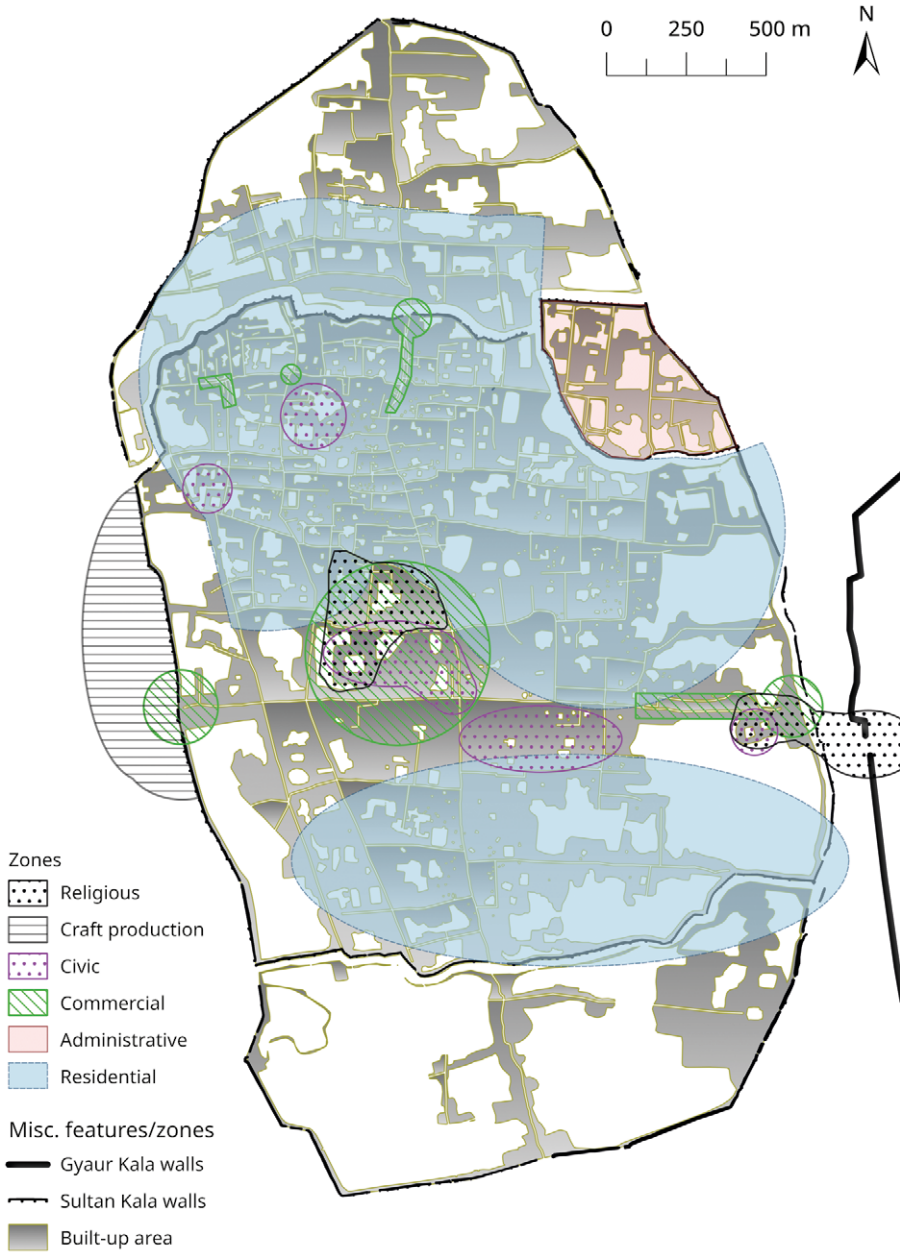

Figure 47. The form and proposed zonal characteristics of Seljuk Sultan Kala.

wall. The irregularity of the southwestern walls, on the other hand, could indicate that there were some urban features in the area that the path of the wall had to accommodate. This is further supported by the alignments of the linear features outside and within the citadel, implying that they existed before the construction of the citadel. The choice of locating the new citadel in a relatively sparsely built-up area in order to have room for such a large complex is intuitive. However, the choice to have it in very close proximity to the central city and incorporated into the city walls is less intuitive, since conceivably a compound with the same amenities and institutions could have been constructed separately yet relatively close to the *madina*, as is the case of other medieval Islamic urban settlements such as Samarra. This form, therefore, warrants consideration. Incorporating the citadel into the city walls would have certainly provided it more security against

attack, especially without any defensive prominence in the natural topography on which to build, but this pattern corresponds to other urban settlements in Sogdia and Eastern Iranian cities such as Baigand, Zaranj, Herat, and at Merv with Gyaur Kala (Gangler *et al.* 2004). It also appears in the later Timirid city of Merv, Abdullah Khan Kala. As discussed in Section 4.7.2, this square tripartite city form was an ancient pattern in Central Asia, dating at least to the early first millennium CE, and was maintained in some cities and smaller urban settlements.

The citadel was equipped with all the necessities in which to rule not just the city, but an empire, as well as amenities to take care of the sultan. Located inside the citadel was a mosque, barracks, and gardens. More significant, however, is that Sanjar moved his residences and the *Dar al-Imara* there, as well as constructing other administrative features such as the mint and an audience hall. This move symbolically and literally distanced the sultan, future governors, and the administrative civic institutions from the civil life of the city. The shift in the residences and administrations roughly corresponds with a greater gradual shift in urban settlement patterns in the 9th century in which Abbasid ruling elites increasingly shifted and/or constructed their palatial compounds within rural areas outside of cities (Kennedy 2006). The comparison is not exact, in that these palatial compounds were completely separate from the city and usually did not accommodate significant administrative offices. Yet the relocation of the ruling residences and administrative bodies away from the civic centre of cities would persist to become the dominant pattern of Islamic cities usually in the form of citadels beginning in the tenth and eleventh centuries. While the impetus for this shift was likely the practical desire for distance from the noise and bustle of the inner city, it also signified the increasing divergence of the sultan and governors from official religious duties to more secular ones. The peripheral placement of the ruling elite and administration within a walled compound would also have symbolic significance. In Umayyad and Early Abbasid periods, the caliph or governor was placed at the centre of the city to be accessible to the people, to take part in civic duties and life, and indeed to appear central to them. In contrast, by the 12th century when Shahryar Ark was built, the lives of the sultan and governors were more private, and they and administrative institutions were entities to be separated and protected behind walls away from common citizens. This increased spatial separation between administration and the populace may reflect an increase in social separation, meaning an increase in social stratification (Karimian 2011).

The form of Sultan Kala that was constructed during the reign of Sultan Sanjar is chiefly its most recent and final form that is currently visible. Apart from the yet extant tomb, or mausoleum, of Sanjar that was constructed on the site of the former *Dar al-Imara* some time after his death, there were no other topographically identifiable significant urban features constructed thereafter. However, the mausoleum had a substantial influence on the urban fabric of the city centre, as excavations have revealed that it was a part of a complex of adjoining structures which included a mosque, *madrasa*, and a *hamam*. Interestingly, the mausoleum would have been accessed from these other adjoining structures through its roof. This, along with a smaller Seljuk period structure found in lower strata (Gye and Hillenbrand 2001), indicates that they were built after the construction of the mausoleum, suggesting further development after the Seljuk period. Yaqut's account of Merv in *Mu'jam ul-Buldan*, describing Merv only a few years before its sacking, although full of praise for the city by virtue of its excellent libraries and madrasas, provides scant topographic or architectural information, and so is of limited use in attempting to determine its formal and developmental status shortly before it was sacked. In the little he does provide, he describes two *jamis*, one for the Hanafiya and the other for Shafi'ya, and

that they shared a wall. This is a detail absent from early accounts, and so might signify an architectural development, but identifying this feature through topography or even excavation could be dubious. Additionally, he indicates that the Majan and the Razik are the two 'rivers' that flow through the streets of Merv. Yaqut's account differs from Istakhri's earlier account, in that he does not mention the Hormuzfarrah or the Asadi Khurusani, which could signify that urban development in Yuqut's time had concentrated within the *madina* proper, or that only Sultan Kala had become to be considered the city. This is dubious speculation, however, as when mentioning Merv, Istakhri was likely referring to the entire oasis or region, and thus included the other two canals. In short, while the fabric of Sultan Kala was modified after the Seljuk period, these modifications would not be identifiable through topography. However, it is unlikely that significant modifications could have been made in the sixty-four years between the end of the Seljuk period and the sacking of Merv, and so the fabric of Sultan Kala was likely fairly fixed by the end of Seljuk rule and represents most of the form of the topography that can currently be seen.

To summarise this section, there were three phases for the development of medieval Merv and Sultan Kala, each expressing a different form. The first is a proto-formative phase that corresponds to the Umayyad period from circa 650 CE/30 AH to 748 CE/131 AH. In this period, some Arab settlers begin to occupy Gyaur Kala, and concurrently, a suburb develops outside the walls of the western gate, likely due to the influx of new settlers and population pressure. During this time, the suburban *rabat* functions as another urban centre in addition to the one in the central part of the walled *shahristan*. It is also during this phase that some small agricultural settlement may have been developing further west around the Majan Canal.

The second is a protracted formative phase, as it covers the time from the beginning of Abbasid rule in 748 CE/130 AH to Seljuk rule in 1037 CE/428 AH, a period of almost 300 years. The reason for the lengthiness of this phase is partially due to the paucity of historiographic sources about Merv during this time that could aid in elaborating on the development periodisation of the city. Topographical analysis alone can only provide speculative conclusions. However, it can be asserted with a reasonable degree of confidence that the Majan 'suburb' continued to develop, becoming the urban centre during this time, while the old city of Merv, Gyaur Kala, increasingly declined. This process presumably went through periods of intensity, with the beginning of the period being a prosperous time when the city was still a regional capital, although this cannot be elaborated without further excavation and stratigraphic phasing.

The third and final phase is one of solidification and corresponds to the beginning of the Seljuk period in 1037 CE/428 AH to the Mongol destruction in 1221 CE/618 AH. This was the second prosperous period of Merv and it underwent significant development as it once again became a provincial capital for a short time before becoming the *Dar al-Mulk*, or capital, during the reign of Sultan Sanjar. The first city walls were erected probably sometime between 1072 CE/465 AH and 1092 CE/485 AH which likely solidified the onetime Majan suburb into the *madina* proper. Suburbs developed along the Majan Canal to the south and especially to the north. Civic institutions, such as *madrasas* and libraries, are attested (Kennedy 1999) to have emerged in the city at this time. As his capital, Sultan Sanjar further developed the city, and is attributed to having enclosed both the northern and southern suburbs within city walls, as well as constructing the walled citadel, Sharhyar Ark. The city developed somewhat after the death of Sanjar, as is evidenced by the reinforcement of the city walls and the

construction of his mausoleum with its assemblage of associated structures, but the form that medieval Merv assumed during the Seljuk period is chiefly the form that is currently observable.

7.2 Assessment of the mapping and the resultant data

Unfortunately, due to the absence of data from 'ground-truthing' the site, it is not possible to provide a fully conclusive appraisal of its mapping and urban morphological analysis. It is expected that the knowledge gained from ground-truthing – whether it was by targeted excavation, GPR, or simple on-site observation – would have increased the accuracy of identifying urban elements from the observed archaeological features. This would have provided a more reliable baseline for the mapping process, which itself was intended to produce a reasonably accurate base map to be used for analysis. It can be concluded with near certainty that at least some of the features and urban elements were misidentified, but without the information garnered from the field, the level of accuracy is fairly speculative. The lack of relevant field data also means that most of the conclusions drawn from the topography are speculative, or at best conditionally presumptive.

The conclusions that can be made from assessment of the urban morphological analysis of the base map are far less unsatisfactory than those from the mapping process. This is in part because the base map is more suited for generalised interpretations due to the lack of detail (such as plots and structures) at finer scales. While specific detailed conclusions are warranted and desired when interpretive data are sufficiently comprehensive with a high degree of confidence, in contrasting cases, generalised inferences are likely to have a higher degree of accuracy than specific claims. For instance, morphological regions of Sultan Kala are morphologically broad enough that it is probable that they do reflect relatively accurate spatially and developmentally distinct areas of the city. These broad inferences can used to guide field work and further research. They can subsequently be disproven or modified and given added nuances as new data arises, providing this added value.

Yet the most fundamental obstacle in providing a sound assessment of the mapping is one that is common to archaeology. This is the problem of missing data and representative sampling of the archaeological record. Normally, this problem is mitigated by statistical means, but due to the lack of ground-truthing, such means were not possible in this study. Additionally, while statistical methods address problems of representative sampling in the known archaeological record, they cannot address what is unknown and unexpected. Translating to the process of mapping Sultan Kala refers to the use of only observable surface features, representing the final 'stage' of the city's development, as well as that at least some of the transcribed target features (voids and linear features) were likely missed.

A significant point to be made, unfortunately, is that the development of Sultan Kala from a suburb of Gyaur Kala to an entirely separate urban centre would admittedly not have been evident without the elaborations from historic accounts about the city. The topography does not divulge that trajectory of change clearly through discernible palimpsests.

This signifies that the application of urban morphological analysis to understanding the physical *development* of other archaeological urban sites could be limited, depending on the qualities of a given site. Despite these shortcomings, the resultant map is a useful means for an understanding of Sultan Kala. It provides an organised visualisation of features and spaces as well as the relationships between them.

Chapter 8: Conclusions

8.1 The utility of urban morphological theory in archaeology

Although this study focused on only one urban site, the observations made in the course of the study can be used to presuppose the utility of the methods applied to other sites. Some aspects and methods of urban morphology are already familiar to archaeology, such as natural determinants, agency, and space-syntax. Other approaches considered significant within the field of urban morphology, such as the concept of Conzenian townscapes and the process typological approach of Caniggia and Maffei, have not impacted archaeology. The degree to which the study of urban morphology can be practical and informative in its application to urban archaeological sites will differ between sites based on their qualities and the aims of the research. Site qualities, such as construction material, state of preservation, and amount of site exposure, will determine which urban morphological approaches can be applied and how detailed or informative the resulting conclusions can be. In short, the *legibility* of the site determines the approach to be assumed.

The utility of urban morphology in archaeology, therefore, is a spectrum. Toward one pole of the spectrum are the sites of which their morphology/features are fairly legible. Such details allow for the application of most analytical urban morphological approaches (spatial-analytical, historic-geographic, *etc.*). In such cases, the goal of such morphological research would be particularly aimed at revealing something about an urban settlement's development and/or its social-spatial system. Toward the other end of the spectrum are naturally the sites where the features and morphology

are not so legible. In these cases, the range of urban morphological approaches is more restricted around the historic-geographical approach. While some speculations and conclusions about site development and social-spatial relationships could be made in these cases, the goal of the application of urban morphological thought and mapping methods would be more exploratory or 'experimental'. Morphological maps could aide in directing specific research questions and conjectures that could then be 'tested' by topographically and morphologically targeted field investigation. Admittedly, without conducting similar work on other sites and/or validating the interpretations from the work on Sultan Kala with fieldwork, both of these possible modes of application and utility are only conceptual.

A more immediate use of morphological theory in archaeology is the online publication of GIS overlay maps. Maps as GIS packages can easily be published online, with the data either available for download or through a GIS-browser, making them easily accessible to researchers. By providing adequate metadata and organised overlay layers, the map and the process by which it was created is made transparent. Online publishing of GIS data does not only enable the map data to be used as a resource for research itself, but also allows for it to be interrogated, revised, and reinterpreted by others (Kropf 2017). This should encourage dialogue that could improve the map/transcribed data and therefore expand knowledge, for example, about Merv.

8.2 The evolution of medieval Merv

The forms and developmental trajectories of medieval Merv correspond suitably to some currently accepted conceptualisations of Early Islamic urbanism, and the knowledge gained from the study of medieval Merv may indeed augment them. Having developed from an extra-mural suburb of Gyaur Kala, Sultan Kala conforms to the processes of urban-suburban transformation of urban settlements in Central Asia after the Arab invasions as illustrated by Sobti (2005). Like many other cities of the region, such as Bukhara and Paikend, due to migrations and population pressures during the early stages of Arab Muslim rule, Merv developed a substantial suburb which became an additional urban core or centre of the city in itself. Morphologically, Sultan Kala also conforms to the walled tripartite urban structure of *quhandiz, sharhristan* and *rabad* that developed in this period and superseded the bipartite urban structure that existed before the conquest. However, Merv seems to have been one of the few settlements, possibly the only one other than Afrasiab/Samarkand, that diverted from this pattern in that a new settlement was created and the old one was abandoned. It would be difficult to determine the reason(s) for this separation with any conviction without straightforward evidence, but it likely resulted from socio-political factors, natural topographic factors, or a combination of the two.

The morphology of Sultan Kala also encourages an interpretation that approximately concurs with the thesis of AlSayyad (1991, 153), in which the

> *"internal organization of each such town was negotiated between the governor of the town and its inhabitants, while its overall form resulted from negotiations between the caliph, who was concerned with enforcing the Islamic ideal of community, and the governor, who had to deal with the immediate needs of the local population."*[85]

85 Here he is specifically referring to early garrison towns. Although Sultan Kala was not a garrison town, the foundation of the urban core adjacent to the Majan Canal makes the situation roughly analogous. Moreover, this thesis may be flexible enough to apply it to other cases as well.

In application to Sultan Kala, mediation between inhabitants/governor and governor/caliph is exhibited in its urban fabric/tissue and the arrangement of monuments and city form, respectively. More specifically, the morphology of medieval Merv reveals different administrative urban forms superimposed on a local vernacular pattern of internal settlement structure. The local vernacular settlement structure refers to the urban pattern associated with areas of Persian influence of urban irrigation through a system of *jub* lined orthogonal streets, reservoirs, and pools, as has been previously outlined. While it is not known if Gyaur Kala exhibited this urban system, it can confidently be asserted that this agriculturally rooted system was at least known in the Merv Oasis before the Arab conquest as streets with *jubs* are attested to other ancient regional settlements such as Bukhara.

The administrative aspect of medieval Merv's urban form refers to the placement and arrangement of the state institutions and monuments by the governor or caliph/sultan. As with many Early Islamic cities (both inherited and created), in Gyaur Kala the initial *Dar al-Imara* – congregational mosque complex – was placed at the centre not simply for practical reasons, but more due to politic-religious symbolism. The proximity of the mosque and palace structures demonstrated the close ritual role of the caliph/governor and government (AlSayyad 1991), while its relatively central location within the urban fabric embodied that the caliphate should be unified and singular. Although density, population pressure, and the junction of the Majan Canal and the main east-west road had some influence on the choice of location of the new *Dar al-Imara* – congregational mosque complex – and with little doubt, the placement of it outside of Gyaur Kala by Abu Muslim after the Abbasid uprising was intentionally symbolic to some degree, if not significantly. The intention may have been to either symbolically impose the state onto a suburb or settlement that had begun to develop in that area, or to intentionally attract development to eventually form a new urban core or entirely separate *misr* as a symbol of the new Abbasid Caliphate, although these possibilities are not mutually exclusive. According to Istakhri, the Abbasid governor of Khurusan, Tahir ibn al-Husayn, even wanted to move the *Dar al-Imara* and markets of Merv further to the west along the Hormuzfarra Canal, possibly as an attempt at independence (Kennedy 1999). If true, this gives support for the symbolic significance of moving the civic core complex of the city.

The *Dar al-Imara* – congregational mosque complex – used in the Early Abbasid Caliphate was a continuation of urban patterning from the Umayyad Caliphate, and as the era of the latter was a time of the spread and settlement of Arab culture and peoples, this form could be associated within an Arab state milieu. The complex became the core of the main urban area by attracting development in its vicinity. This process likely occurred slowly, on the whole, but with periods of intensity over the course of roughly three-hundred to four-hundred years between the Early Abbasid period and into the Seljuk period. Muqaddasi alleges that until the time of al-Ma'mun's residency in Merv from 809 CE/194 AH to 818 CE/202 AH, the "Old Mosque" at the western gates of the old city were ruinous, but that he had restored it. Additionally, his house was purportedly located either adjacent to the Radjik Canal, or adjacent to Erk Kala, the old *quhandiz*.[86] Depending on its accuracy, this description may suggest that there was a period where the areas in and around Gyaur Kala were relatively deserted, which could then be taken to indicate that there was initially a period of intense development in the Majan suburb. The location of al Ma'mun's "house" outside

86 Muqaddasi seems to have thought these features were adjacent, hence the difference in locations. He therefore may have been entirely mistaken about the location (Kennedy 1999).

of the chief urban area could indicate that a separation between the religious roles of the caliph or governor and the state had already started to develop.

Written around the end of the 10th century and the beginning of the 11th century, referring to both the population and the ruinous condition of the urban areas, the accounts of Istakhri and Muqaddasi make it clear that Gyaur Kala was still occupied at that time, although sparsely. As such, the full transition to Sultan Kala does not seem to have been completed, if the accounts can be taken as accurate. Indeed, Istakhri and Muqaddisi both refer to Gyaur Kala as the "inner city" (Kennedy 1999), though describing the city in this way may express that they conformed to a colloquial conceptualisation of a city more than indicating urban vitality. The time between the Abbasid era and partially into the Seljuk era represents a transitional phase of Merv, in which an administrative urban form was established adjacent to a local form resulting in a conurbated hybrid, dual-centre urban system.

There are two significant aspects to the recognisable Seljuk forms of Merv. The first is its city walls. While there may have been some occupation of Gyaur Kala at the time and after the construction of its city walls, their erection makes it fairly evident that the main occupied urban area was centred along the Majan Canal. Fortifications are a common feature of Seljuk period settlements in Central Asia, which has been suggested to derive from the militaristic aspect of their society and therefore a concern with defence (Adle *et al.* 2003). Although there may be a good deal of truth to this idea, as has been mentioned above, the first "hollow" walls of Sultan Kala were likely not meant to withstand any serious external attack. However, the city wall would have also served to practically and symbolically solidify it as a whole distinct city and community. This is further embedded when the northern and southern *rabads* are later walled.

The second aspect of the morphology of Sultan Kala in this period pertains to the relocation of the palatial complex and administrative offices from the core of the city to a peripheral walled citadel. As discussed above, this move had morphological, functional, and symbolic consequences for the city. What is additionally notable about the transition to an administrative citadel at Merv, along with the walling of the northern and southern *rabads*, is that it morphologically and structurally resembled the tri-partite urban settlement form ubiquitous throughout Central Asia. In addition to the inclusion of the tripartite constituent parts, the *shahristan* of Sultan Kala assumed the form of the inner cities of other cities that had retained the use of their *shahristans* since before the arrival of Islam. Like other cities, such as Nishapur, Buckhara, and Herat, the inner city of Sultan Kala was a relatively square walled area with four gates and two main streets oriented to cardinal directions that intersected in its centre. While the intersection of the Majan Canal and the main east-west road may indicate that the spatial pattern and orientation of Sultan Kala is partially circumstantial, the presence of the tri-partite urban divisions and the encircling of the *jub* street system within the city walls suggest that this regional form was, at least partially, intentional.

Rather than to simply recapitulate the points made in Section 7.2, the aim of the above summary is to highlight perspectives about the different forms of medieval Merv from which two conclusions can be drawn. The first is that to explain the forms of medieval Merv requires a synthesis of the theses of AlSayyad (1991) and Sobti (2005). As with other cities of Central Asia during the Early Islamic period, Merv went through a transformative process of suburbanisation. Yet the urban pattern that resulted from this process was in part a consequence of a combination of the actions of local inhabitants, state agents, and the mediation of desires between the two.

The second conclusion is that the forms of medieval Merv can be interpreted as representing differing *conceptions* of urbanism and cities as well as the products of historical socio-political processes. Vernacular irrigation and agricultural customs characteristic of urban settlements of Greater Iran produced most of the urban fabric of medieval Merv and this conceptual system of urban development seems to have persisted until its sacking. Imposed upon this fabric were a series of urban forms that varied based on ideas of the function and qualities of cities in particular historical contexts. The initial Umayyad urban form focused around a central civic-administrative compound and placed within the regional bipartite city structure suggests that, from an administrative perspective, the city's function was to impose a central, publicly involved, unifying authority. That the *quhandiz* was relatively quickly abandoned after Merv was assumed into the Umayyad empire supports this perspective. This concept of the 'city' carried over to Early Abbasid Merv with the 'founding' of the new congregational mosque and *Dar al-Imara* compound, although the idea with this act was to create a new centre symbolic of the new regime.[87]

During the Umayyad and the Early Abbasid periods, the regional concept of the city and the administrative concept formed a syncretic urban system, although the influence of the Early Abbasid form likely waned from the Samanid period when the Abbasid and Tahirid rule in the region ceased. In the Seljuk period, a new form of Merv coalesced which appears to have had a heavy influence from the pre-Islamic bipartite forms of the region. The initial Seljuk form was presumably limited to the walling of the built-up area in a relatively quadratic form, resembling other pre-Islamic cities such as Herat and Gyaur Kala, without the *quhandiz*. The new and final form of Sultan Kala crystallised when the citadel and suburbs were walled under the rule of Sanjar. As has been previously posited, the structure of this form, specifically the relocation of the administrative and palatial structures to the citadel, likely had symbolic and conceptual significance concerning the role of the state and governor. However, the overall morphology of Sultan Kala may signify the abstract or ascriptive notion of the 'city'. As with other cities in Central Asia, Sultan Kala developed to have a new tripartite system. Unlike other cities, however, Sultan Kala did not assume this form by accretion into a pre-Islamic *shahristan*. Instead, it developed into its own new centre adjacent to a former urban centre, yet the *shahristan* of Sultan Kala exhibits the same quadratic cardinal directed structure as exhibited by other pre-Islamic cities in Central Asia. This return to a former regional urban morphology[88] strongly suggests a partial perpetuation of a regional cultural ideal of city form. It may not be coincidental that this former morphology (re)materialised at Merv after Persianate Turkic dynasties, such as the Ghaznevids and Seljuks, came to power in the region, replacing the former Arabized Persian *dihqan* Samanid and Tahirid dynasties.

It is evident from the historical geographic descriptions of Merv and the source of patronage for the construction of its monuments during certain regimes that its prosperity and form relied heavily on its political status. Building projects, the construction of monuments, and the development of institutions, such as madrasas and libraries, seemed to have intensified when Merv was the seat of a sovereign rather than just a provincial capital. This reinforces the conclusion that the form of Merv was highly contingent on the idea of its political function as a city.

87 This concept of city form/function may have carried over to the Early Abbasid empire as a whole, as further attested by the alleged form of early Baghdad with its central administrative compound.

88 The idea that both pre-Islamic and medieval Merv represented the same type of Eastern Iranian/Central Asian city has also been briefly suggested in Gangler *et al.* (2004), although they do not elaborate on the development and evolution of Merv.

8.3 Suggestion for further research

Although additional data from targeted field surveys and test pits would greatly enhance the methodology that has been applied here to Merv, the absence thereof has already been bemoaned in previous sections and so will not be belaboured here. Rather, there are other areas of inquiry to pursue that could complement and expand upon the knowledge concerning medieval Merv garnered in this study, as well as further contexts in which to assess the efficacy of the methods used here and, possibly, improve upon them.

Perhaps the most palpable direction for furthering themes in this study is to apply the urban morphological theories and methods to other sites with different qualities than that of Merv. With the focus on just a single site, there is the risk of 'tunnel-vision', in which the range of possibilities that could affect the efficacy of the methods used is too narrow for its potential utility to be appreciated. While the Conzenian model and the multiple-nuclei model were the primary approaches used in this study, sites with other archaeological and morphological qualities might enable the application of some of the other methods discussed and the evaluation of how they could complement each other to provide a more complete picture of an urban site's morphological development.

Yet, being such a vast site, there is an incredible amount to be revealed about the urban aspects of Merv and various approaches which could be used. This study focused solely on the intramural areas of medieval Merv, which is a sizable undertaking in itself, yet as with any urban system, the hinterland was integral to the city. The Merv Oasis is dotted with different settlement types. An effort to understand the settlement system of the Merv Oasis by mapping, categorising, and dating the settlement would be a heavy endeavour, but could provide a better understanding of the developmental trajectory of medieval Merv, and the relationships between cities and their hinterlands of Central Asia more broadly.

The urban morphological approaches used in this study have exclusively used cartographic and taxonomic methods, and while these methods are useful for an understanding of the cityscape and its development, the resulting portrayal of the city is artificial. Morphological approaches are a means for external views suited for analysis. These methods are not well-suited to provide an experiential portrayal of the city, which would reveal a more complete and human understanding of Merv's urbanism. One approach to provide a more 'lived' portrayal of the city would be to focus excavations more on residential areas and households, which have been somewhat neglected in favour of the more monumental features of Merv. Investigation into the domestic aspects of Merv would provide a more rounded picture of the city by developing a better understanding of its urban vernacular architecture and commonplace urban living patterns. Additionally, this would also help to more accurately situate Merv within its cultural and geographical context at finer scales than urban form and tissue.

Until a great deal more data from fieldwork can be collected and analysed, most of the conclusions presented in this thesis about the methods used and the spatial and historical development of Merv are speculative. The more confident conclusions made concerning the evolution of Merv are, admittedly, general and not a direct result of the methods employed. However, it is the case that structured inquiry does not always produce specific, certain, or innovative results. Yet it is hoped that the insights presented in this thesis will inspire and give direction to future research.

Summary in German / Deutsche Zusammenfassung

Sultan Kala ist der moderne Name für die mittelalterliche Stadt Merv. Es handelt sich um eine von drei archäologischen Fundstellen städtischer Siedlungen der Merv-Oase in der Karakum-Wüste im heutigen Land Turkmenistan. Merv war ein wichtiges Zentrum entlang der alten und mittelalterlichen Seidenstraßen, seine Stadtanlagen stammen aus dem Zeitraum vom 5. Jahrhundert v. u. Z. bis zum 15. Jahrhundert u. Z. Sultan Kala entwickelte sich bereits im frühen Mittelalter unmittelbar westlich der antiken Stadt Merv, die um das Jahr 650 u. Z. friedlich vom Kalifat der Umayyaden erobert und besetzt worden war. Zu verschiedenen Zeiten war Merv eine bedeutende Stadt in der Frühgeschichte des Islam. Während des größten Teils seiner frühmittelalterlichen Geschichte war Merv die regionale Hauptstadt der Provinz Khorasan unter aufeinanderfolgenden Kalifaten und Sultanaten, und für kurze Zeit war es sogar die primäre Hauptstadt imperialer Staaten. Im Jahr 748 u. Z. begann hier die abbasidische Revolution, die das Kalifat der Umayyaden stürzte, um das abbasidische Kalifat zu errichten. Während der Zeit des großen Seldschukenreiches (1037-1194 u. Z.) entwickelte sich Sultan Kala zu einer eigenständigen Stadt, die die frühere antike Stadt Merv verdrängte. Unter der Herrschaft von Sultan Sanjar (1097-1157 u. Z.) wurde Merv zur Hauptstadt des Seldschukenreiches; zu dieser Zeit wurde die Stadt als Zentrum des Lernens bekannt, da sie viele Bibliotheken und religiöse Schulen hatte. Leider endete der Wohlstand von Merv im Jahr 1221 u. Z., als es von den Mongolen geplündert und praktisch aufgegeben wurde, bis die Timuriden im 15. Jahrhundert u. Z. eine weitere Stadt in der Oase bauten.

Sultan Kala gilt als eine der wenigen mittelalterlichen islamischen städtischen Siedlungen, die keiner intensiven modernen Entwicklung unterzogen wurden. Dies bedeutet, dass die archäologischen Ressourcen des Ortes größtenteils erhalten geblieben sind und ein anschauliches Bild der Stadt zur Zeit ihrer Plünderung bieten können. Weil sie jedoch der Witterung ausgesetzt waren, sind viele der Bauwerke von Sultan Kala abgetragen worden oder eingestürzt, auch wenn einige Denkmäler, wie die Stadtmauern und Eliteresidenzen, teilweise noch stehen. Die Überreste der Stadt bilden rund 600 Hektar einzigartiger archäologischer Topographie.

Sultan Kala hat eine Geschichte als Schwerpunkt archäologischer Forschung, wenngleich diese aufgrund politischer Probleme in geringerem Umfang stattfand, als normalerweise für eine historische Stadt und einen solch einzigartigen Fundplatz zu erwarten wäre. Die erste ernsthafte akademische archäologische Untersuchung von Merv begann als sowjetisches Unternehmen Mitte des 20. Jahrhunderts, als Southern Turkmen Archaeological Complex Expedition (YuTAKE). Diese Expedition führte in den 1970er Jahren Bodenuntersuchungen, Ausgrabungen und insbesondere eine fotografische Luftaufnahme durch. Diese Fotografien zeigten, dass in der archäologischen Topographie von Sultan Kala städtische Merkmale wie Straßen und Zonen erkennbar waren.

Seit den 1990er Jahren hat das University College London im Rahmen des Ancient Merv Project archäologische Forschungen in Merv durchgeführt. In den frühen 2010er Jahren wurde im Rahmen des Projekts Sultan Kala mit einem unbemannten Luftfahrzeug (UAV) detailliert fotogrammetrisch vermessen.

Die Qualität der Daten aus der UAV-Vermessung, die für die vorliegende Arbeit zur Verfügung gestellt wurden, bietet eine Möglichkeit, die Topographie, Mikrotopographie und allgemeine Morphologie von Sultan Kala durch den Einsatz von GIS-Anwendungen effizient zu kartieren und zu erkunden. Das Entwickeln einer Karte eines so großen Standorts kann sich als nützlich erweisen, da Merkmale visuell organisiert und räumlich referenziert werden. Eine Karte ist jedoch auch ein Mittel zur Analyse und Untersuchung. Welche Prozesse und Methoden sind notwendig, um eine nützliche Karte zu erstellen? Wie kann die durch eine solche Karte dargestellte Morphologie von Sultan Kala analysiert und interpretiert werden und etwas über die räumlichen Eigenschaften der Stadt und ihre Entwicklung aussagen? Dies sind die primären Fragen, denen in dieser Arbeit nachgegangen wird.

Doch bevor diese Fragen angesprochen werden, sollen zunächst die historischen, geografischen und kulturellen Kontexte skizziert werden. Es ist wichtig, zu beachten, dass die Provinz Khorasan und ein Großteil des westlichen Zentralasiens bis zur Ausbreitung des mongolischen Reiches im 13. Jahrhundert u. Z. unter starkem Einfluss der persischen Kultur standen. Dies war ein Einflussfaktor auf die Form und Entwicklung von Merv. Der in dieser Arbeit betrachtete Zeitraum liegt zwischen ungefähr 650 u. Z., als die Umayyaden ankamen, und der Plünderung von Merv durch die Mongolen im Jahr 1221 u. Z. Es sind jedoch vor allem zwei Perioden in der Geschichte von Merv, die seine Morphologie und Entwicklung prägten. Die erste beginnt nach der Revolution der Abbasiden im Jahr 748 u. Z., als Abu Muslim, der neue Gouverneur von Khorasan, den Bau eines neuen Regierungsgebäudes und einer Gemeindemoschee in einem Vorort außerhalb des alten Merv neben dem Majan-Kanal anordnete. Diese Bauwerke verlagerten das Zentrum des Stadtlebens und der Stadtentwicklung vom alten Merv zum Vorort Majan, was schließlich in der Entstehung einer separaten Stadt, Sultan Kala, gipfelte. Die zweite Periode betrifft das Seldschuken-Reich (1037-1194 u. Z.) und insbesondere die Herrschaft von Sultan Sanjar (1097-1157 u. Z.). Während seiner Regierungszeit war Merv die

Hauptstadt des Reiches und durchlief drastische Veränderungen und städtische Entwicklungen. So wurden unter anderem die Innenstadt und die Vororte von Sultan Kala mit Stadtmauern umgeben und der Palast in eine ummauerte Zitadelle verlegt. Die Form, die Merv während der Seldschukenzeit annahm, ist größtenteils die Form, die heute in seinen Ruinen zu sehen ist.

Für die Analyse der Morphologie von Sultan Kala stützt sich diese Arbeit im Wesentlichen auf zwei Forschungsgebiete, nämlich die urbane Morphologie und den islamischen Urbanismus. Die urbane Morphologie hilft, den Urbanismus im Allgemeinen zu verstehen und zu analysieren. In dieser Arbeit wird die urbane Morphologie als die Untersuchung der Struktur menschlicher Siedlungen und ihrer Veränderung definiert. Bevor die theoretischen Ansätze und Methoden zur Stadtmorphologie skizziert werden, ist es notwendig, sich zunächst den verschiedenen Definitionen von „Stadt" zuzuwenden, wobei jedoch keine universelle Definition erreichbar ist. Vielmehr muss eine Arbeitsdefinition basierend auf der Ausrichtung der Untersuchung bereitgestellt werden. Darüber hinaus gibt es verschiedene Möglichkeiten, Städte zu klassifizieren, wie z. B. „organisch gewachsene" gegenüber „geplanten" und „politische" gegenüber „wirtschaftlichen" Städten. Es ist wichtig, zu beachten, dass die meisten vormodernen Städte „politisch" waren.

Auch die für die Analyse erforderlichen Elemente der urbanen Form können je nach Untersuchungsansatz variieren. Übliche städtische Analyseelemente sind Straßen, Gebäude, Grundstücke, Blocks und verschiedene Arten von Freiflächen (Grünflächen, Höfe usw.). Es ist notwendig, sich darüber im Klaren zu sein, dass die Bezeichnungen für Elemente der urbanen Form, die für die Analyse verwendet werden, oft Form und Funktion in sich vereinen. Zum Beispiel kann „Haus" sowohl ein Gebäude bezeichnen als auch vermitteln, dass es bewohnt ist. Solche „Verschmelzungen" können die Analyse erschweren, wenn nicht darauf geachtet wird.

Üblicherweise werden in stadtmorphologischen Studien das konzentrische Modell, das Sektormodell und das Mehrkernmodell verwendet. Diese Modelle versuchen zu beschreiben, wie Städte räumlich wachsen und sich separate Zonen mit unterschiedlichen Funktionen entwickeln. Sektor- und Mehrkernmodell wurden aus dem konzentrischen Modell entwickelt und sind anspruchsvoller, da sie mehr Nuancen als nur äußeres Wachstum ausdrücken. Da sie intuitiv sind, kann die Verwendung dieser Modelle einen gewissen Wert bei der Beschreibung der Zonen von Merv, aber auch von anderen archäologischen Fundplätzen städtischer Siedlungen haben.

Im Bereich der Stadtmorphologie gibt es im Wesentlichen vier verschiedene theoretische Ansätze: räumlich-analytisch, konfigurativ, prozesstypologisch und historisch-geographisch. Während alle diese Ansätze nützliche Rahmen für das Verständnis der gebauten Umwelt bieten, sind sie nicht alle für archäologische Zwecke anwendbar, da sie entweder hochgenaue räumliche Daten erfordern oder nicht dazu dienen, die Stadtentwicklung zu erklären. Die historisch-geographische Herangehensweise ist die Ausnahme. Dieser Ansatz beinhaltet die erstmals von Conzen (1966) entwickelte „Stadtplananalyse", bei der die in einer Grundkarte einer Stadt dargestellten urbanen Elemente analysiert werden, um unterschiedliche morphologische Regionen zu identifizieren, die Bereiche differenzierter Entwicklung darstellen. Bei entsprechender Modifikation könnte dieser Ansatz für archäologische Zwecke angewendet werden.

Um den physischen urbanen Wandel zu verstehen, ist es zunächst notwendig, die Kräfte hinter dem Wandel zu kennen – und welche Formen er annehmen kann. Außerdem muss zwischen „Entwicklung" und „Evolution" unterschieden werden.

„Entwicklung“ bezieht sich auf die Geschichte der Veränderung einer Sache (einer Stadt), und „Evolution“ bezieht sich auf die Veränderung von Arten von Dingen (ein gemeinsames Muster der Stadtform). Die „Determinanten“ des urbanen Wandels können in zwei Kategorien eingeteilt werden: menschliche und umweltbedingte. Menschliche Determinanten ergeben sich aus Handlungsfähigkeit und Verhaltensmustern, während Umweltfaktoren sich aus physikalischen Eigenschaften des Landes wie Topographie und verfügbaren Baumaterialien ableiten. In Bezug auf Merv hatten menschliche Determinanten wahrscheinlich einen größeren Einfluss auf seine Form als Umweltdeterminanten, da die Topographie des Gebiets ziemlich flach ist und somit die einzigen weiteren Einflussfaktoren die Kanalsysteme und der Boden für Baumaterial wären. Es gibt im Großen und Ganzen drei Formen der Stadtentwicklung: Verdichten, Ersetzen und Wachsen. Schon allein durch die Untersuchung der archäologischen Topographie könnten das Verdichten der Bebauung und das Wachstum einer Stadt erkennbar sein, aber das Ersetzen von Gebäuden wäre wahrscheinlich nicht sichtbar.

Das zweite Studiengebiet, aus dem sich diese Arbeit stark speist, ist der islamische Urbanismus. Es gibt eine bedeutende Geschichte der wissenschaftlichen Erforschung der „islamischen Stadt“, die im frühen 20. Jahrhundert beginnt. Die Idee der „islamischen Stadt“ hat aus vielen Gründen verdiente Kritik erfahren, aber der Hauptgrund dafür ist, dass die geografische und zeitliche Vielfalt in islamischen Städten bis vor kurzem nicht vollständig gewürdigt wurde. Außerdem wurde der Einfluss der Religion auf die Struktur islamischer Städte auf Kosten anderer Faktoren zu stark betont.

Unter Berücksichtigung der oben genannten Vorbehalte kann das Verständnis der Muster in den Strukturen islamischer Städte eine Grundlage für das Verständnis von Sultan Kala bilden. Historisch gesehen gab es je nach Status verschiedene Klassen islamischer Städte, aber um als Stadt zu gelten, musste eine Siedlung als Mindestvoraussetzung eine Gemeindemoschee (*masjid jami*) haben. In der frühen islamischen Geschichte war das *masjid jami* räumlich gepaart mit dem *Dar al-Imara* (Haus der Regierung / des Gouverneurs), und dieses Ensemble befand sich in der Nähe des Zentrums der Siedlung, in dem sich die Spezialitätenmärkte befanden. Islamische Städte entwickelten sich im Verlauf des Mittelalters von diesem Muster weg, als die religiöse Rolle des Gouverneurs/Kalifen schwand. Stattdessen befanden sich Palast- bzw. Regierungsgebäude eher außerhalb oder in ummauerten Zitadellen innerhalb der Stadt.

Ein weiterer gemeinsamer Aspekt islamischer Städte ist die sequentielle Unterteilung verschiedener Ebenen der Privatsphäre. Islamische Städte wurden üblicherweise nach ethnischer Zugehörigkeit, Religion oder Stammeszugehörigkeit in Viertel eingeteilt. Diese Quartiere können sogar ummauert sein. Tatsächlich erwähnte der Geograph al-Istakhri aus dem 10. Jahrhundert u. Z. Merv sogar für die Aufteilung seiner Viertel. Quartiere können mehrere Nachbarschaften haben, die um öffentliche Einrichtungen wie Moscheen, Schulen und lokale Märkte angeordnet sind. In kleinerem Maßstab werden Häuser um Sackgassen herum gruppiert, um Hauscluster zu bilden, die von verwandten Familien bewohnt werden.

Historische Städte im Großiran, unter denen sich auch Merv befindet, gelten als eine Untergruppe islamischer Städte. Sie bestehen üblicherweise aus drei Teilen: der Zitadelle (*quhandiz*), der Innenstadt (*shahristan*) und dem Vorort (*rabad*). Sowohl die Zitadelle als auch die Innenstadt sind ummauert. Im Gegensatz zu Straßen islamischer Städte in anderen Regionen sind die Straßen iranischer Städte rechtwinklig zueinander ausgerichtet. Dieses Muster ergibt sich im

Zusammenhang mit landwirtschaftlichen Bewässerungssystemen, in denen kleine Kanäle (*jub*) rechtwinklig von einem Hauptkanal (*qanat* oder *shah jub*) abzweigen, um Felder in Siedlungen zu bewässern. Die Straßen folgen dem Verlauf der Kanäle, und während die Siedlung wächst, werden die Felder sukzessive mit Gebäuden gefüllt. Die linearen Merkmale, die in der Topographie von Sultan Kala zu sehen sind, folgen ebenfalls einem rechtwinkligen Schema und zweigen vom Majan-Kanal ab, sodass davon ausgegangen werden kann, dass die Stadt einen ähnlichen Wachstumsprozess durchlaufen hat. Die historischen Städte Zentralasiens gelten als eine Untergruppe der iranischen Städte, doch weisen sie als bedeutendsten Unterschied ummauerte Vororte auf. Dies ist die Form, die auch Sultan Kala zeigt und die sich in dieser Region vermutlich als Prozess der Suburbanisierung nach der Ankunft des Islam und der Araber im 7. und 8. Jahrhundert u. Z. entwickelt hat.

Bevor die Morphologie von Merv gründlich analysiert werden kann, muss zunächst die Topographie untersucht, interpretiert und transkribiert werden. Geeignete Visualisierungstechniken können bei der Identifizierung archäologischer Merkmale helfen. Es wurden drei Hauptdatensätze verwendet, die aus den photogrammetrischen UAV-Messdaten abgeleitet wurden: ein Farbdatensatz (RGB), ein digitales Höhenmodell (DEM) mit Schummerung und eine „Heatmap" des DEM. Außerdem wurde das DEM überhöht skaliert, um das Relief in der Topographie besser sichtbar werden zu lassen. Diese Datensätze betonen Merkmale unterschiedlich, sodass durch Querverweise zwischen den Datensätzen die archäologischen Merkmale identifiziert werden können.

Die Topographie von Sultan Kala ist komplex, es sind nur sehr wenige einzelne Strukturen zu erkennen. Lineare Merkmale, die wahrscheinlich Straßen oder Kanäle waren, sind jedoch gut sichtbar. Darüber hinaus gibt es viele eingesunkene und bewachsene ovale Merkmale. Diese entstehen durch den besonderen Prozess des Zusammenbruchs von Gebäuden, die um Höfe herum angeordnet sind, ein gemeinsames Merkmal der islamischen Architektur. Daher waren Straßen/Kanäle und Freiflächen wie Höfe die Hauptklassen von Merkmalen, die transkribiert und analysiert werden sollten.

Zur Vorbereitung der Analyse und Identifizierung wurden die Merkmale zunächst klassifiziert. Für die Freiflächen geschah dies auf zwei Arten: zum einen allein anhand ihrer Größe und zum anderen sowohl anhand ihrer Größe als auch anhand ihrer Lage. Die Größe der Klassen wurde durch eine kleine Untersuchung der Hofgrößen verschiedener Arten von Gebäuden (Moscheen, Karawansereien, Residenzen usw.) bestimmt, die in städtische, öffentliche, kommunale und Wohngebäude verallgemeinert wurden. Große Freiflächen wurden weiter in *Green Space*, *Grey Space* und *Incidental Space* kategorisiert. Straßen und Kanäle wurden basierend auf ihrem Grad an Konnektivität in sechs Kategorien eingeteilt. Um die visuelle Analyse zu erleichtern, wurde jeder Klasse eine andere Farbe zugewiesen.

Mit Hilfe der verschiedenen Klassen konnten bei der Analyse der städtischen Topographie von Sultan Kala elf verschiedene morphologische Regionen und zwei Unterregionen identifiziert werden. Diese morphologischen Regionen repräsentieren ebenso wie in der „Stadtplananalyse" Bereiche differenzierter städtebaulicher Entwicklung. Zusätzlich wurde jedoch die mögliche Lage von Zonen, die unterschiedliche Landnutzungsmuster repräsentieren, visualisiert (in Bezug auf die Sektor- und Mehrkern-Stadtmodelle). Bei den lokalisierten Zonen handelt es sich um religiöse, administrative, kommerzielle, Produktions- und Wohnzonen. Dieses Modell wurde auf sechs verschiedene Perioden angewendet, beginnend kurz vor der Ankunft des Islam um 650 u. Z. bis zur Plünderung von Merv im

Jahr 1221 u. Z. Diese Methode war hilfreich, um zu verstehen, wie sich Sultan Kala physisch aus dem alten Merv entwickelt haben könnte.

Es sollte jedoch beachtet werden, dass unklar ist, inwieweit die durch den oben geschilderten Prozess erzeugten Visualisierungen die tatsächliche Morphologie von Sultan Kala widerspiegeln. Die transkribierten Merkmale und Regionen von Merv sollten daher als interpretativ betrachtet werden. Dies liegt zum Teil daran, dass keine Überprüfung mittels Feldarbeit durchgeführt wurde. Diese hätte möglicherweise mehr Daten erbracht, die Informationen darüber hätten liefern können, wie zuverlässigere Transkriptionen erstellt werden können.

Trotz aller Vorbehalte in Bezug auf die Richtigkeit der Interpretation und die Zuverlässigkeit der Visualisierung erwies sich der Kartierungs- und Analyseprozess als nützlich. Er half, mögliche Bereiche differenzierter Morphologie und Entwicklung zu identifizieren, was einen Ausgangspunkt für die Aufstellung kausaler Hypothesen und die Anregung weiterer Feldforschung darstellt. Wenn neue Daten verfügbar werden, können die Bereiche verfeinert und korrigiert werden. Wenn die Karte frei verfügbar ist, kann sie außerdem verwendet werden, um verschiedene Interpretationen vorzunehmen, die sich gegenseitig ergänzen können.

Die Ergebnisse des Kartierungs- und Interpretationsprozesses lassen sich wie folgt zusammenfassen: Die Entwicklung der Formen des mittelalterlichen Merv repräsentiert einen Wandel in der damaligen Vorstellung von „Stadt“. Beginnend mit dem alten Merv, das eine regionale Stadtform darstellte, veränderte sich die Stadt nach der Ankunft des Islam. Der Stadt wurde ein administratives und religiöses Zentrum hinzugefügt, das die Macht des neuen abbasidischen Staates widerspiegelte. Um das administrativ-religiöse Zentrum herum entwickelte sich ein Vorort, der zum neuen Lebensmittelpunkt von Merv wurde – ein Prozess, der zeitgleich auch in anderen Städten Zentralasiens stattfand. Eine landestypische, iranische Form der Landwirtschaft und Stadtentwicklung gab dem Vorort seine unverwechselbare Morphologie. Im Gegensatz zu anderen Städten Zentralasiens entwickelte sich der Vorort jedoch während der Seldschukenzeit, als die Stadt ummauert wurde, zur völlig eigenständigen Stadt Sultan Kala. Diese letzte Form von Merv, die wieder eine Zitadelle und eine Innenstadt hatte, ähnelte eher der vorislamischen Stadtform. Das mittelalterliche Merv ist ein Beispiel für die „Evolution“ der Stadtform in Zentralasien.

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Appendix I: Glossary

ark (variously as arg): Persian for fortress.

bab: Gate.

bazar: From Persian meaning 'market' in a general sense. More specifically, the term refers to a complex of covered streets with commercial establishments; *suq*.

caravanserai: A Persian term roughly meaning inn, but from the Early Islamic period it signified a structure where merchants could house themselves and their pack animals while also being a place of exchange. They occurred in both urban and rural settings. Found along important trade routes, and rural examples were often fortified and exhibited many urban amenities, such as mosques and markets.

chahar-su: Persian; the intersection of four bazar lined streets in a city; often covered.

Dar al-Imara: Primary administrative building for a city and region. It also occasionally indicated the residence of the governor; literally 'house of the governor.'

dar al-mulk: Used to refer to a capital city; 'house of government.'

darb (pl. durub): Small or secondary street; lane.

dihqan: A high status land owner in the Persianate world; noble.

district: A zone which comprises multiple neighbourhoods. Like neighbourhoods, districts can be sociospatially delimited, but can also be officially defined for administrative purposes.

hammam: A bathhouse, most often public.

jub: Persian; an open water channel. In rural/semi urban contexts, it is used for irrigating agricultural fields. In urban settings, they often follow the same path as streets and alleys, and could be used for both acquiring potable water and

drainage/runoff, depending on the flow of water and the share schedule of the community.

kala (also qala, qal'a): A fortification, citadel.

madina (pl. mudun or mada'in): Used in a general sense for 'city', but also a district capital.

madrasa: Higher education religious and legal schools. Thought to have originated in Khurasan, possibly in Merv.

mashrabiya: A type of domestic balcony covered by a wooden screen for shade and privacy.

Masjid al-Jami: The primary mosque – often monumental in urban settings – to which the men in a community gather on Fridays. Often shortened to Jami and also called the 'Friday' or 'Congregational' mosque.

Mawarannahr: Arabic for Transoxiana.

maydan: Persian term referring to the main 'square' in a city, which is usually located between important institutional or landmark buildings, such as the Jami, madrasa, citadel, *etc*.

misr (pl. Amsar): This term may be defined in various ways depending on the context and usage. As an official or technical term, it denoted urban settlements that served an administrative function and were dominant over others in a region. In colloquial usage it meant any metropolitan city.

neighborhood: A primarily residential socio-spatial zone within an urban area where there is an increased likelihood of familiar interaction.

qal'a: Often translated to 'citadel', but can also be a standalone fortress or fortified settlement. Note the term in the modern names of the settlements of Merv: Sultan Kala, Erk Kala, *etc*.

qanat: Underground irrigation channels for urban and agricultural usage.

qaryah (pl. qurun): A village or hamlet.

qasabah (pl. qasabat): In its technical medieval sense, a provincial capital. It can be very roughly translated to 'town,' and is used in this sense in modern Persian.

qibla: The direction of prayer towards the Ka'bah in Mecca.

rabad: Often translated to 'suburb'; extramural urban development.

urban tissue: The aggregate of distinct areas of a settlement that are discernible by particular combinations of urban elements (streets, buildings, blocks, open spaces, materials, *etc.*) and exhibiting styles representative of distinct periods of development. Similar to the Conzenian concept of 'plan unit'.

zone: Any identifiable spatial unit (Smith 2010) of an urban area, with respect to land-use and/or activity. Examples include: ceremonial zones, residential zones, neighbourhoods, districts, *etc.* However, note that the examples are inclusive, in that they contain smaller spatial units, and hence a spatial unit such as a 'plot' cannot be considered a zone.

zuqaq: Alley.

Appendix II: Tables

Layer\Layer Group	Dependent Layers
Soviet Aerial	clip 1909 clip 1844 clip 1910 clip 1845 clip 1844b clip 1753b clip 1753
RGB	shark 2cm orthomosaic alpha rgb transparent merv19 2011 2cm sksouthwest mosaic rgb transparent merv27 mosaic group1 transparent merv22 2011 2cm southeast mosaic rgb transparent merv21 2011 2cm south mosaic rgb transparent merv16 2011 4cm central3 mosaic rgb transparent merv15 2011)4cm central2 mosaic rgb transparent merv11 2011 4cm run2 mosaic rgb merv6processing orthomosaic alpha rgb merv5processing orthomosaic alpha rgb merv4processing orthomosaic alpha rgb merv3processing orthomosaic alpha rgb merv2processing orthomosaic alpha rgb transparent merv26 mosaic group1 transparent merv14 2011 4cm centralpart1 mosaic rgb
Heatmaps	merv22 2011 2cm southeast dsm merv4processing orthodsm geo merv26 dsm merv25 shaimkala dsm merv17 2011 2cm skcentral dsm shark 2cm orthodsm geo merv6processing orthodsm geo merv5processing orthodsm geo merv11 2011 4cm run2 dsm merv15 2011)4cm central2 dsm merv16 2011 4cm central3 dsm merv3processing orthodsm geo merv2processing orthodsm geo shark 2cm orthodsm geo merv27 dsm merv14 2011 4cm centralpart1 dsm merv20 2011 2cm skwest1 dsm merv13 2011 4 kyz kala evening dsm
Hillshade	Same as heatmaps (see above).
Multidirectional Hillshade	Same as heatmaps (see above).
Bing	NA

Table II.1. Organisation of the raster data layers and layer groups in QGIS.

Class	Name	Location	Period
Congregational Mosques	Al-Mutawakkil	Samarra, Iraq	Abbasid 847-859
	Abu-Dulaf	Samarra, Iraq	Abbasid 859-861
	Masjud e Kufa	Kufa, Iraq	Umayyad
	Ibn Tulun	Fustat, Egypt	Abbasid 879
	Great Mosque	Qayrawan, Tunisia	Abbasid 836, 13th century
	Atiq/Great Mosque	Isfahan, Iran	Abbasid 10th century
	Masjid-i Jami	Mahdiya, Tunisia	Fatimid 912
	Azhar Mosque	Cario (Fustat), Egypt	Fatimid 969-72
	Al-Hakim	Cairo (Fustat), Egypt	990-1013
	Great Mosque of Al-Mansur	Baghdad	Abbasid
	Masjid-i Jami	Niriz/Neyriz, Iran	Abbasid? 972
	Kaylan	Bukhara	1121 (modif. 1515)
	Jami al Kabir	Sanaa, Yemen	630, 753, 1130
	Masjid-i Jami	Sfax, Tunisia	Abbasid / Aghlabid 849, 1059-1100
	Masjid-i Jami	Sousse, Tunisia	Abbasid /Aghlabid 851, 10th, 11th
	Great Mosque/Al-Qadim	Raqqa, Syria	Abbasid 772, Seljuk 1165
	White Mosque	Ramla, Palestine	Umayyad – Ayyubid 1047, 1190
	Masjid-i Jami	Aleppo, Syria	11th-14th century
	Jameh	Ferdows, South Khorasan, Iran	Seljuk 11th century (possibly 7th)
	Jameh	Fahraj, Yazd, Iran	Umayyad 8th century
	Great Mosque	Diyarbakir, Turkey	Seljuk 1092
	Jameh	Yazd, Iran	Buyid, 11th century (re. 1365)
	Grand Mosque	Banbhore, Pakistan	727
	Jam-i Masjid	Herat, Afghanistan	Ghurid 1200
	Jameh	Qazvin, Iran	807
Local Mosques	Masjid-i Heydariyyah	Qazvin, Iran	Seljuk 1119
Madrasas	Shah-i Mashhad (Madrasa/ mausoleum)	Murghiib Valley, Afghanistan	Gurid 12th century
	Mustansiriya	Baghdad, Iraq	1228-1233 (nominally) Abbasid
	Madrasa Ech Chamaiya	Tunis, Tunisia	1236
	Saffarin Madrasa	Fez, Morocco	1271 (Maranid)
	Madrasa al-Nuriyya al-Kubra	Damascus, Syria	1167 Seljuk (Zengid)
	Al-Firdaws Madrasa	Aleppo, Syria	1236 Ayyubid

Table II.2. Sizes of public structures and courtyards.

	Courtyard Area (m^2) and Percentage	Total Area (m^2)	Source
	14,300 (38%)	37,284	Cowin, Northedge and Kennet (2015)
	14,000 (48%)	28,890	Cowin, Northedge and Kennet (2015)
	5,500 (50%)	11,000	Petersen (2002); Cowin
	8,464 (49.5%)	26,244/17,080	Petersen (2002)
	3,484 (38%)	9,112	Petersen (2002)
	4,675 (31%)	14,935	Petersen (2002)
	1,700 (36%)	4,675	Petersen (2002)
	1,732 (27%)	6,375 (currently 15,600)	Petersen (2002)
	5,148 (38%)	13,560	Torky (2022)
	3,960 (modif.)	Unknown	Creswell and Allan (1989)
	277 (13 or 7%)	2,056 (with forecourt 4,093)	Archnet (n.d.*f*); Cowin
	3,195 (30%)	10,531	Herdeg (1990); Cowin
	1,500 (31%)	4,800	Finster (1992); Cowin
	200 (11%)	1,830	Zangar (2022); Cowin
	922 (31%)	3,009	Binous (2022); Cowin
	4,000 (40%)	9,936	Archnet (n.d.*a*); Cowin
	3,977 (51%)	7,812	Rosen (2006)
	3,600 (42%)	8,600	Petersen (2002); Cowin
	777 (34%)	2,265	Cowin
	140 (29%)	480	Hillenbrand (2000); Cowin
	1,700 (29%)	5,900	Petersen (2002); Cowin
	1,117 (15%)	7,500	Archnet (n.d.*e*); Cowin
	374 (26%)	1,443	Khan (2002)
	4,920	18,112	Golombek (1983)
	4,700 (27%)	11,800	Archnet (n.d.*d*); Cowin
	1,230 (41%)	3,000	Cowin
	660 (34%)	1,936	Najimi (2015)
	1,670 (35%)	4,800	Archnet (n.d.*b*); Cowin
	70	Indeterminate	Ben Mami (2022); Cowin
	175	Indeterminate	Hillenbrand (1994); Cowin
	342	Unknown	Archnet (n.d.*c*)
	240 (15%)	1,645	Tabbaa (1997); Cowin

Class	Name	Location	Period
Caravansaries	Ağzikara Han	Ağzikarahan village, Aksary, Turkey	1231-1240
	Hanabad Caravanserai	Cardak, Denizli, Turkey	13th century Rum Seljuk
	Sultan Han	Sultanhani, Aksaray, Turkey	1229 Seljuk
	Sultan Han	Kayseri, Turkey	1232 Seljuk
	Ribat i-Malik	Uzbekistan	12th century Seljuk
	Ribat i-Sharaf	Khorasan Province, Iran	12th century Seljuk
Funduqs (Urban Caravansaries)	Funduq Shamma'in-Sbitriyyin (contiguous double Funduq)	Fez, Morocco	11th-13th century (restored 1290-1293)

Table II.2 continued.

	Courtyard Area (m^2) and Percentage	Total Area (m^2)	Source
	615 (23%)	2,625	Esroy (2022); Cowin
	360 (20.5%)	1,760	Cowin
	1,340 (27%) (2,552 (52%) including under arcade)	4,900	Yavuz (1997); Cowin
	853 (22%)	3,807	Yavuz (1997); Cowin
	375 (5%) (possible internal courtyard)	7,700	Hillenbrand (2000); Cowin
	534, 995 (25% combined) (semi-double court design)	6,135 (Cowin)	Hillenbrand (2000)
	133 and 91 (23% combined)	985	Cambazard-Amahan (1989); Cowin

Household ID	House (m^2)	Courtyard (m^2)	Courtyard %
62	42	13	31
61	58	34	59
59	72	18	25
71	78	14	18
58	84	37	44
4	89	20	22
63	96	28	29
57	101	49	49
7	112	57	51
72	115	37	32
5	120	50	42
43	125	74	59
20	141	55	39
9	141	64	45
74	142	28	20
70	147	65	44
46	152	46	30
15	155	57	37
40	159	86	54
2	170	45	26
73	176	36	20
8	182	76	42
60	194	55	28
28	212	124	58
25	217	77	35
21	226	153	68
19	250	166	66
6	251	105	42
13	252	152	60
81	255	95	37
10	301	107	36
53	312	100	32
12	346	213	62
82	362	213	59
33	382	347	91
47	417	151	36

Table II.3. House and courtyard sizes in Aliabad, Iran (Source: after Kramer 1982, except for Courtyard % column).

Household ID	House (m^2)	Courtyard (m^2)	Courtyard %
14	448	151	34
16	566	110	19
34	583	470	81
65/66	85	22	26
49	115	22	19
64	124	14	11
77/78	136	40	29
1	141	68	48
48	142	42	30
67	146	51	35
29/30	160	60	38
18	161	51	32
41/42	165	70	42
68/69	172	43	25
44/45	199	86	43
23	215	75	35
3	253	82	32
37/38	275	65	24
39	280	108	39
26/27	304	124	41
31/32	319	139	44
35/36	345	155	45
54-56	366	58	16
11	449	222	49
17	453	122	27
50-52	475	91	19
75/76	638	184	29
22/24	756	226	30
79/80	1358	763	56

Morphological Region	Description
A	Characterised by having mostly – long – thoroughfares and being bound on two sides by arterial routes that intersect at its southeast corner. Additionally, there is a lack of domestic sized open spaces. There is also a clearly identifiable "civic" courtyard structure, which may be related to the "*Dar al-Imara* – Communal Mosque complex" mentioned in the historiographic literature as being in this area.
B	Characterised by a sparse route structure – particularly thoroughfares and dominance of large open "green" spaces with few domestic spaces.
B1	This area is related to Area B by its sparsity in thoroughfares, but may be distinguished by its additional sparsity in voids/abundance in space, interpreted as "built-up". The area's development might also be related to Area A, which would also warrant its distinction.
C	This area is characterised by a moderate density of thoroughfares and cul-de-sacs which are mostly east-west oriented. It also has a number of domestic sized open spaces located close to the route that follows the Majan Canal to its west.
D	This area is typified by a high density of both its route structure and open spaces/voids, especially of domestic sized voids.
D1	Distinguished by the series of lateral cul-de-sacs that branch off from the thoroughfare that borders the sub-area to its south.
E	Area E is distinguished by large and marginal open spaces with no visible urban open spaces. Additionally, the linear structures may be water drainage/overflow conduits rather than part of the route system.
F	Characterised by the rib-like and sparse route structure.
F1	This sub-area is distinguished by the lateral thoroughfares that branch from the Majan Canal/arterial route and the presence of domestic open spaces.
G	Characterised by the root-like route-system/water conduits and the dominance of seemingly open space.
H	Like area "G", this area is dominated by open-space, but has only one visible linear feature.
I	This area is distinguished by being known as the citadel ("Ark") for the Seljuk palace.
J	This area is characterised by the long lateral cul-de-sacs and an abundance of large open spaces.
K	K is distinguished by a moderate dense route structure and significant open space.

Table II.4. Morphological regions and their sub-regions of Sultan Kala as analysed from the extant topography.

Appendix III: Maps

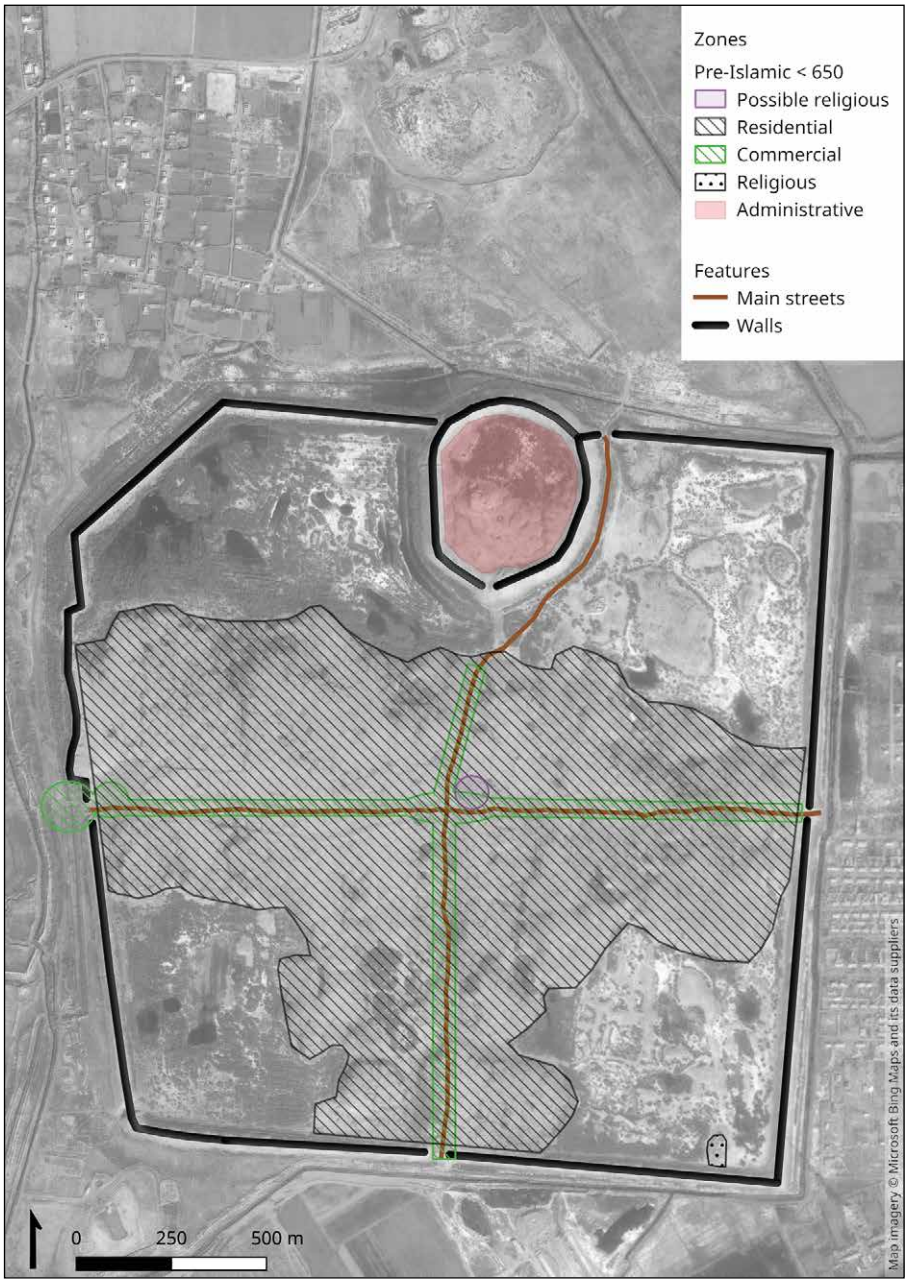

Figure III.1. The form and zones of ancient Merv before the arrival of Islam at ca. 650 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

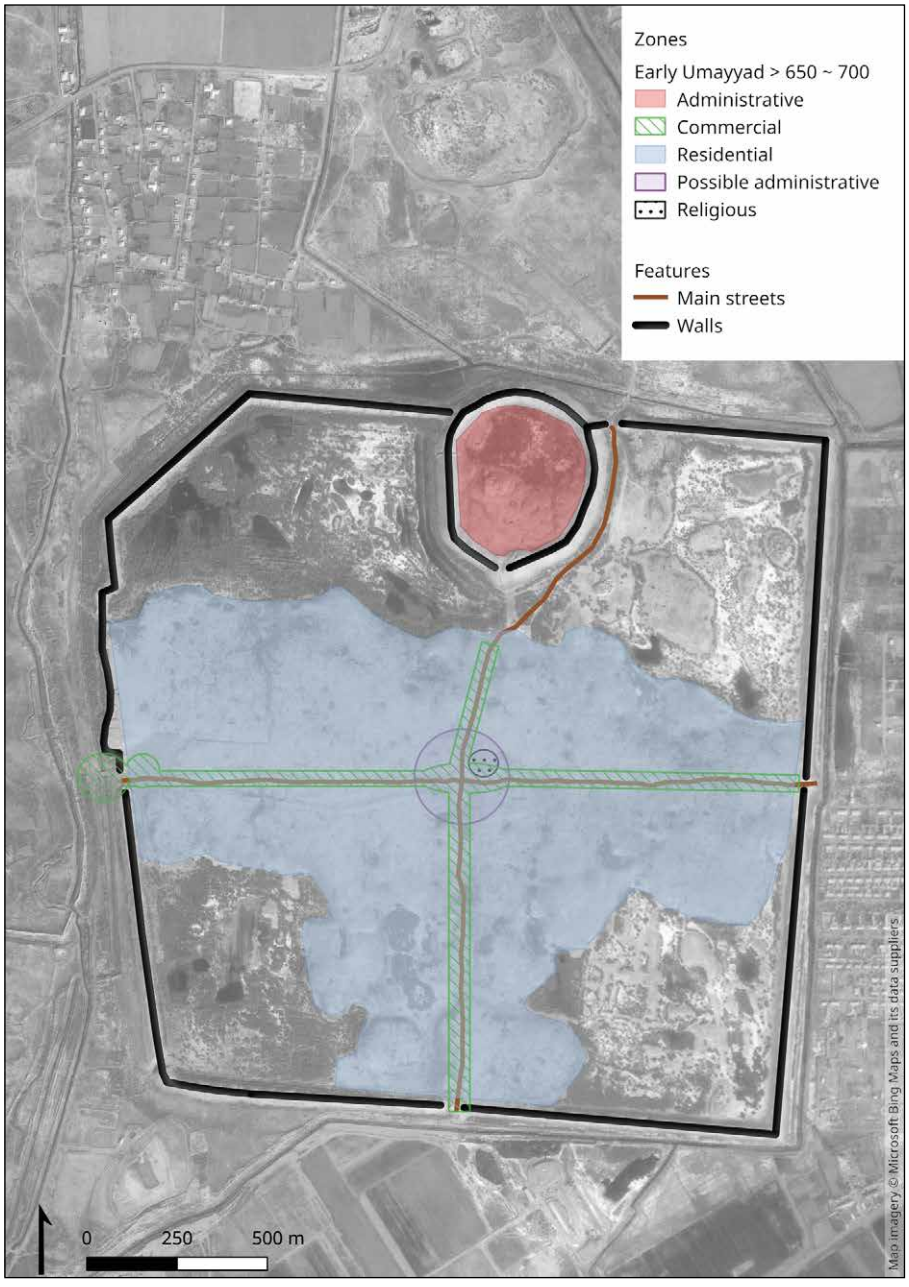

Figure III.2. The form and zones of Early Umayyad Merv ca. 650-700 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

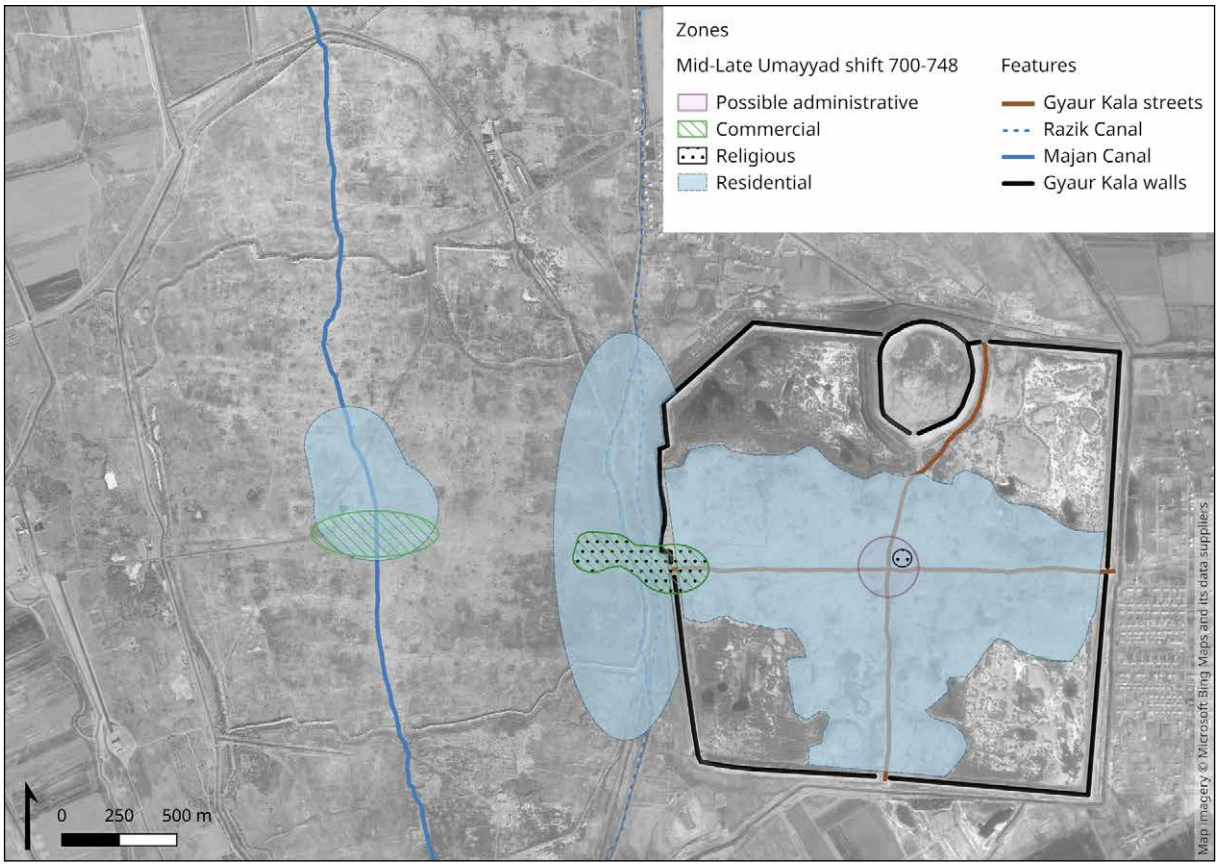

Figure III.3. The form and zones of Mid-Late Umayyad Merv ca. 700-748 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

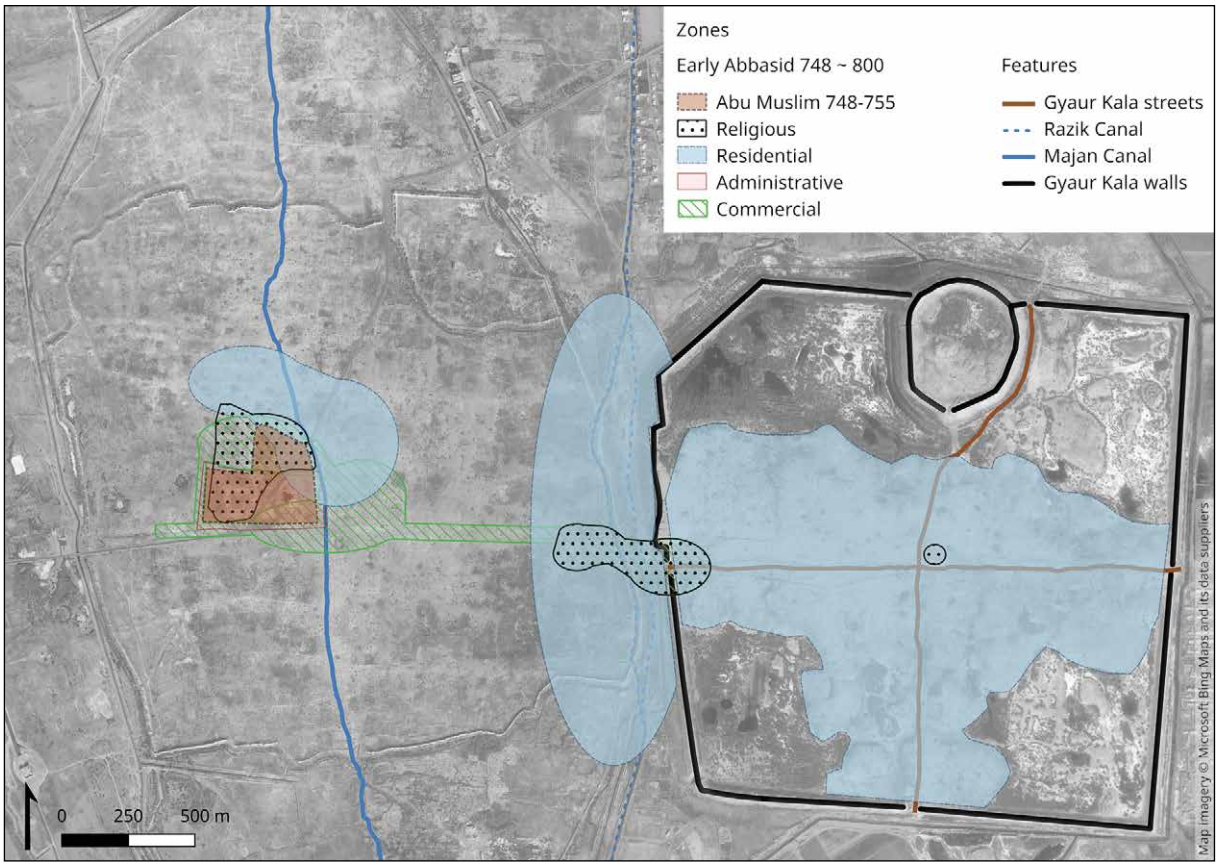

Figure III.4. The form and zones of Early Abbasid Merv ca. 758-800 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

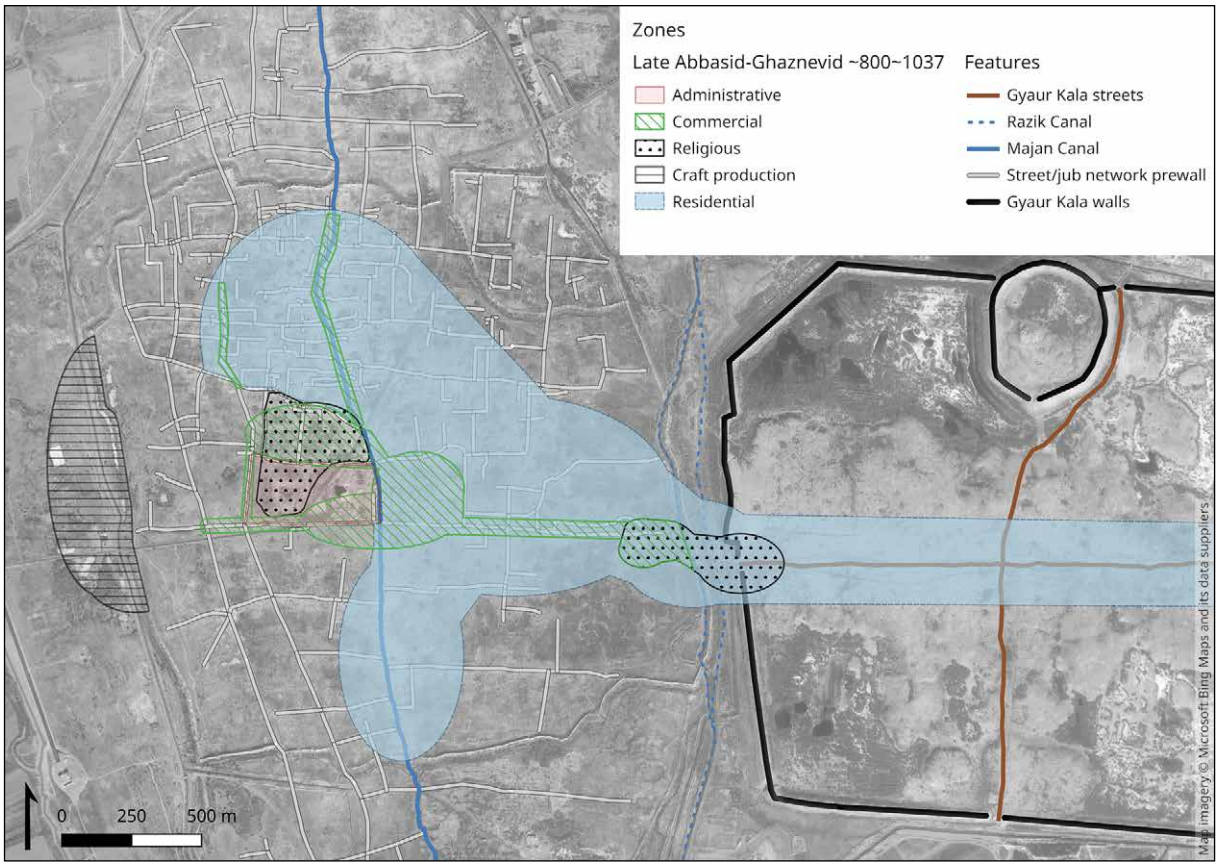

Figure III.5. The form and zones of Merv between Late Abbasid and Ghaznevid periods ca. 800-1037 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

Figure III.6. The form and zones of Sultan Kala after the beginning of Sultan Sanjar's rule in 1097 CE (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

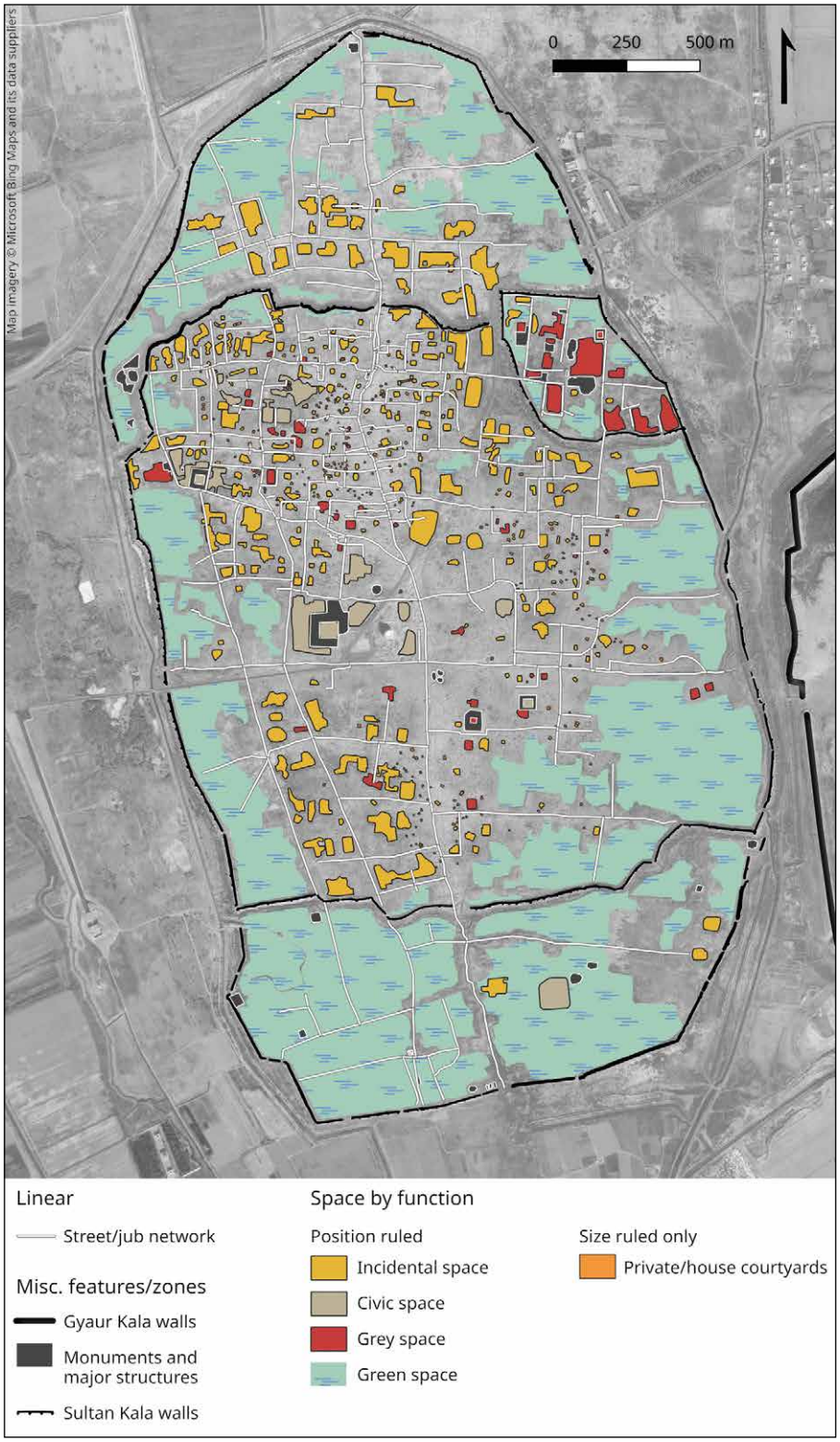

Figure III.7. Map showing the different classes of voids according to their size and relative location (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

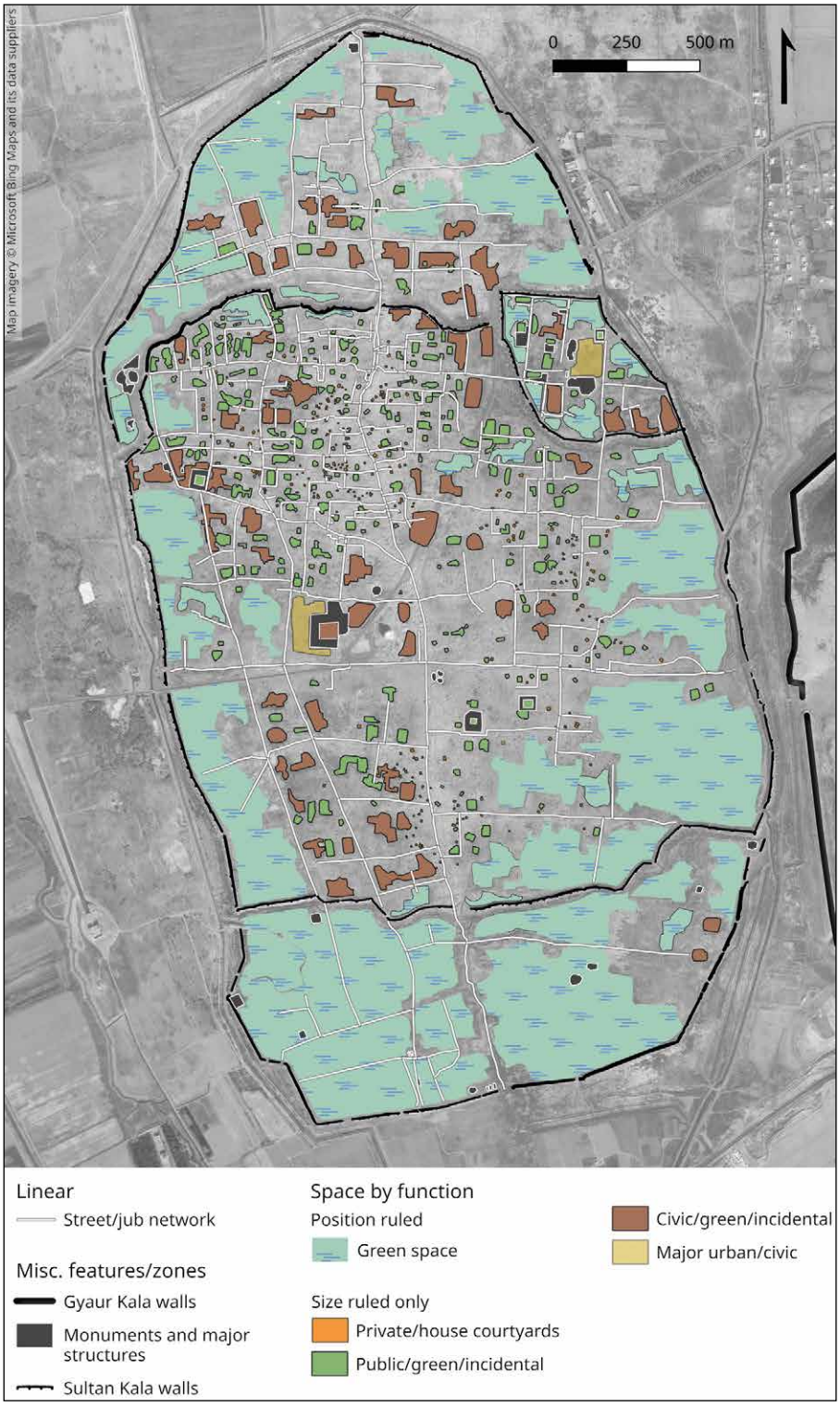

Figure III.8. Map showing the different classes of voids according to their size (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

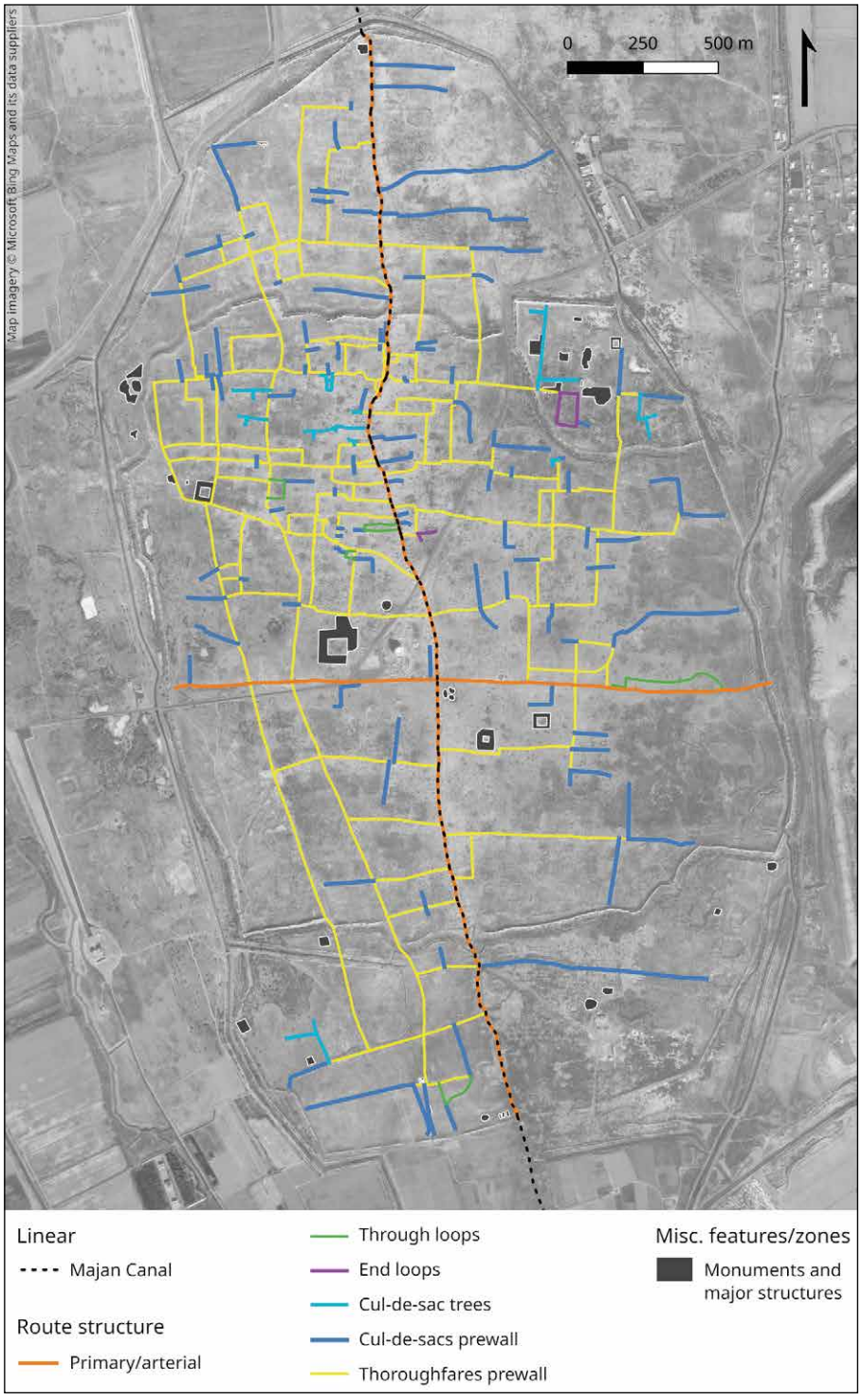

Figure III.9. Map showing the hypothesised route structure prior to the construction of the city walls (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

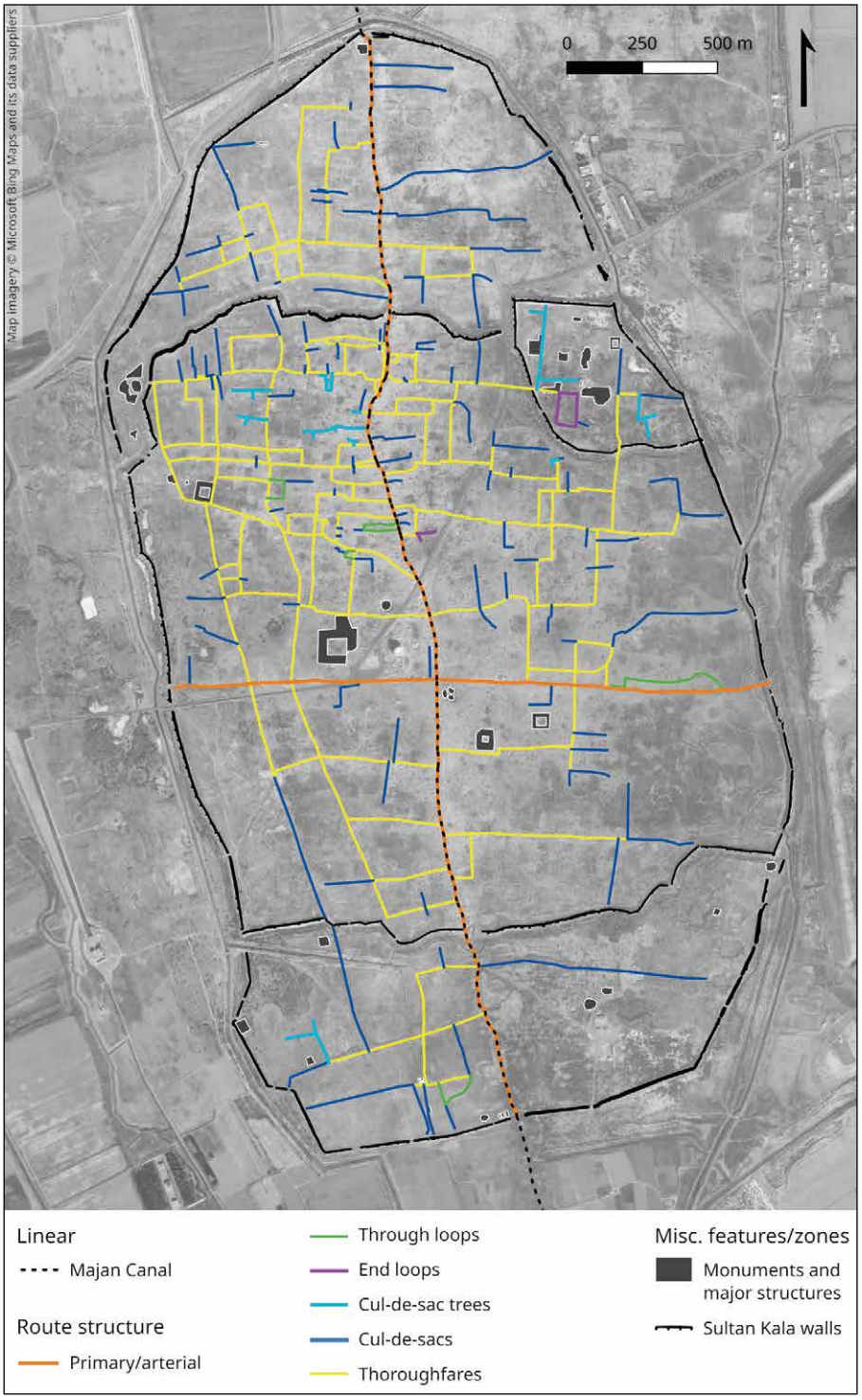

Figure III.10. Map showing the route structure after the construction of the city walls (Source: image created by the author using a Bing Satellite base layer. Map imagery © Microsoft Bing Maps and its data suppliers).

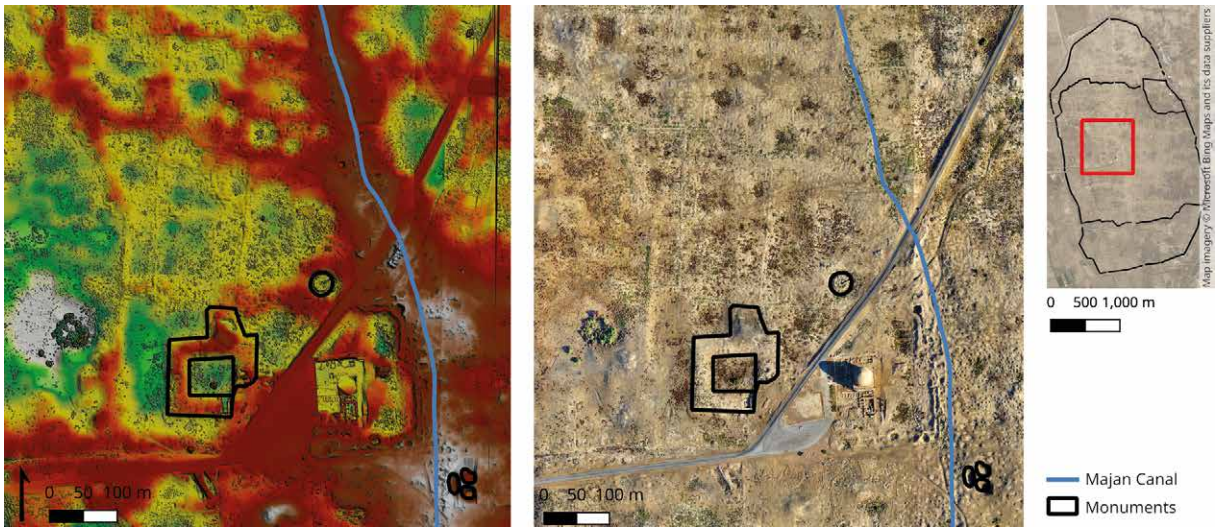

Figure III.11. Detail of the centre of Sultan Kala showing the tomb of Sultan Sanjar, which is reportedly built on the site of the former *Dar al-Imara* adjacent to the *jami*. The *jami* may be located to the north of the tomb where the circular structure is located, which was allegedly the base of the minaret (Source: image created by the author after photos by G. Jorayev, using QGIS map elements and a Bing Satellite base layer for the small overview maps. Map imagery © Microsoft Bing Maps and its data suppliers).

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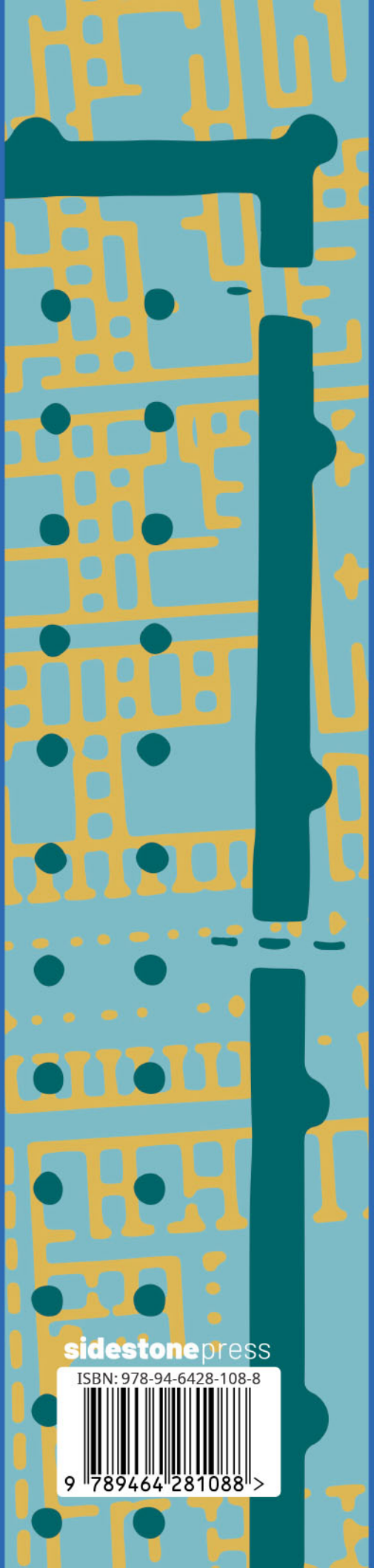
Mapping Medieval Merv

An Exploration into the Application of Cartographic Analysis and Urban Morphological Theory to an Urban Archaeological Site

Situated within the vast Karakum desert of western Central Asia, the Merv oasis exhibits a trove of archaeological sites, owing to its rich ancient and medieval history. Likely due to its strategic location along the historic Silk Roads, the oasis boasts no less than three distinct urban sites, each corresponding to a different period.

During the Islamic Golden Age (8th-13th centuries CE), the city of Merv flourished as a significant centre of Islamic scholarship and occasionally served as a capital. Unfortunately, its prosperity ended abruptly in 1221 CE when it was sacked by the Mongols. Today, the site known as Sultan Kala remains relatively untouched by modern development, setting it apart from many other early Islamic cities. Consequently, Sultan Kala presents a vast and intricate urban archaeological topography.

What can this topography reveal about the medieval history of Merv? This study employs drone imagery, geographic information systems (GIS), archaeological data, and historical sources to explore the archaeological topography of medieval Merv, with a particular focus on Sultan Kala, and how it reflects the city's historical layout. Drawing upon concepts from the field of urban morphology and scholarly research on Islamic urbanism, this study seeks to analyse and interpret the city's form, shedding light on its unique development during the early centuries of Islam. Through this investigation, Merv emerges as a testament to the diversity and evolution of Islamic urbanism in Central Asia during the early medieval period.



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