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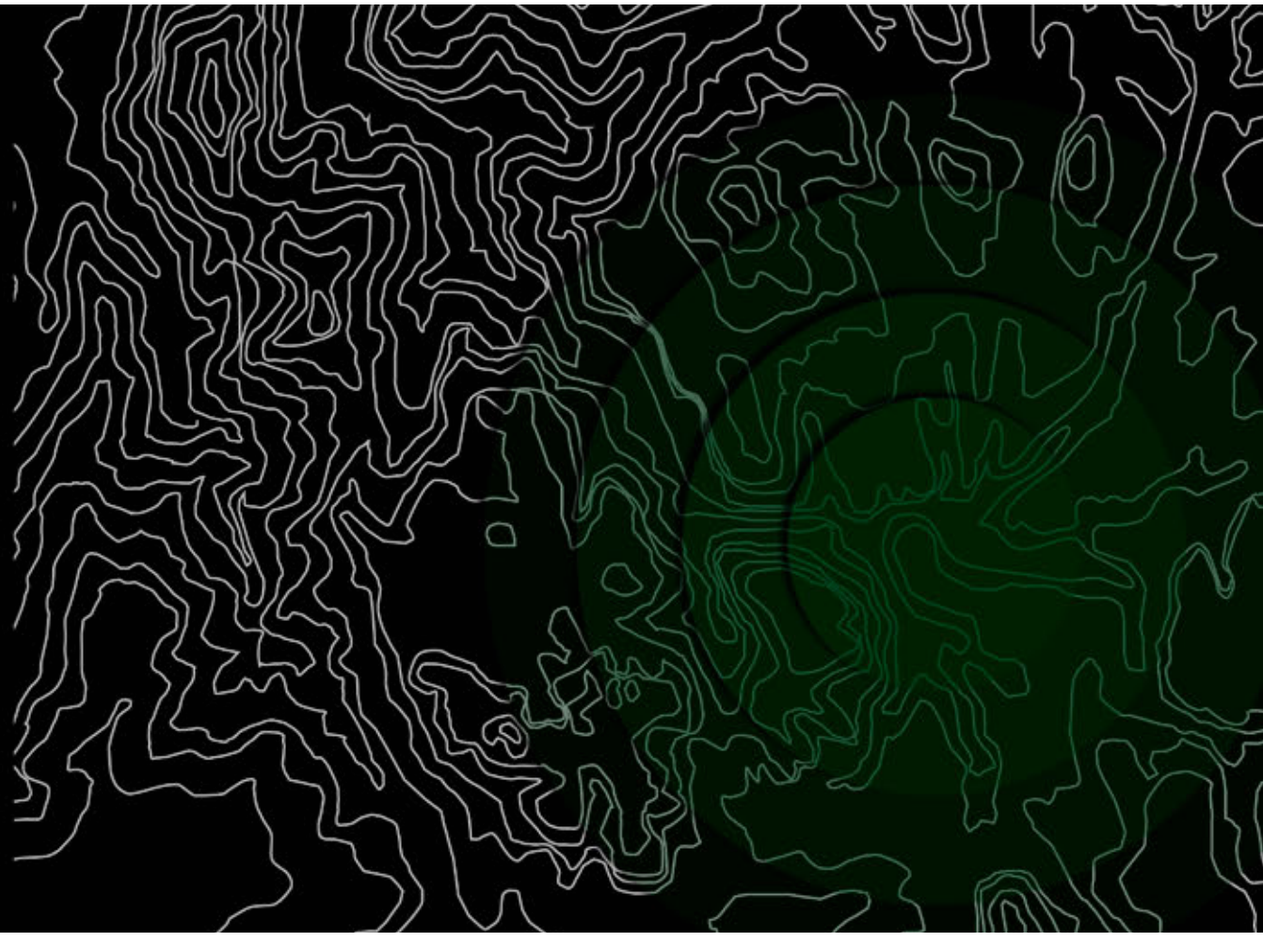
PAULA KOUKI

THE HINTERLAND OF A CITY

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Rural settlement and land use in the Petra region from the Nabataean-Roman to the Early Islamic period

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HELSINKI 2012

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Paula Kouki

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ABSTRACT

The aim of this study is to examine the changes in settlement and land use in the hinterland of the ancient city of Petra, southern Jordan, in the light of archaeological, environmental and ancient textual sources, between ca. 300 BC–early 7th century AD. Central questions are how changing social and economic situations and environmental conditions influenced rural settlement patterns and land use.

The initial establishment of rural settlement in the Petra region took place during the last two centuries BC, followed by a considerable expansion of settlement and agriculture in the 1st–2nd centuries AD. The emergence of permanent settlement and agriculture is seen as the result of the gradual transformation of Nabataean society through the wealth generated by trade and contacts with sedentary peoples. The intensification of agriculture is generally contemporary with the urban expansion of Petra in the last decades BC–early decades AD, and can be linked to the peak of the economic and political influence of the Nabataeans in the Near East.

The rural settlement in the hinterland of Petra began to contract by the 3rd century, with continued decrease of settlements and relocation of population within the region through the 4th century. The settlement pattern that emerged in the 5th century was that of nucleated agricultural villages and towns. At the same time new farming settlements were established in the eastern desert margin of the region, while the western periphery of Wadi 'Araba was gradually emptied of settlement. The 6th century witnessed a continued agricultural expansion towards the eastern desert margin, but most of these new settlements were already abandoned in the 7th century.

It is concluded that the climatic change did not have a significant role in the relocation of settlement, since the expansion of farming settlements towards the environmentally marginal areas took place during a period of increased aridity. It is suggested instead that there are two phenomena partially overlapping in time: first, a concentration of landed properties, starting in the 2nd century, and second, a change to a more mobile strategy of land use in the 3rd century. The latter is considered to be related to the decrease of urban population and wealth in Petra as a result of the empire-wide economic and political disturbances, and the subsequent changes in the international trade routes as well as the political reorganization of the Eastern provinces. These changes resulted in the reorientation of the economy of Petra towards agricultural production and localisation, as well as the emergence of a landowning elite in Petra and its neighbouring towns, reflected also in the distribution of rural settlement from the 5th century onwards. The process is comparable to that in other parts of the Byzantine Empire.

ABSTRAKTI

Tutkimus käsittelee maaseudun asutuksen ja maankäytön muutoksia Petran muinaiskaupungin vaikutusalueella Etelä-Jordaniassa n. 300 eKr.–630 jKr. Tarkastelen, kuinka muuttuvat ympäristöolot sekä vallitsevat taloudelliset ja sosiaaliset olosuhteet vaikuttivat maaseudun asutukseen ja maankäyttöön. Tutkimusaineiston muodostavat arkeologiset tutkimukset, ympäristöaineistot sekä historialliset lähteet.

Petran maaseudun asuttaminen alkoi 200-luvulla eKr. Pysyvän asutuksen ja maanviljelyn alku Petran alueella liittyi alkujaan nomadisen nabatealaisen yhteiskunnan muutokseen, jonka voidaan katsoa olleen seurausta karavaanikaupan tuomasta vaurastumisesta ja yhteyksistä sedentaaristen väestöjen kanssa. Tätä seurasi nopea asutuksen kasvu ja maanviljelyn tehostuminen ajanlaskumme ensimmäisellä vuosisadalla. Nämä ilmiöt ovat samanaikaisia Petran urbanisaation ja väestönkasvun kanssa aikana, jolloin myös nabatealaisten taloudellinen ja poliittinen vaikutusvalta Lähi-idän alueella olivat huipussaan.

200-luvulle jKr. tultaessa maaseudun asutus alkoi harveta, ja sama kehitys jatkui läpi 300-luvun. 400-luvulla asutus alkoi keskittyä kyliin ja pieniin kaupunkeihin ja sen painopiste siirtyi Petran alueen itäosaan, kun taas Wadi 'Araban puoleiset läntiset osat autioituivat. Maanviljelyn ekspansio kohti itää ja aavikkoaluetta jatkui läpi 500-luvun. 600-luvulla suurin osa 500-luvun uusista asutuksista oli kuitenkin jälleen hylätty ja asutus painottui entistä selvemmin kyliin ja pikkukaupunkeihin.

Koska maanviljelyn ekspansio ympäristöltään marginaalisille alueille tapahtui samanaikaisesti ilmaston kuivumisen kanssa, vaikuttaa siltä, että ilmastonmuutos ei ollut merkittävä tekijä asutuksen sijoittumisen kannalta. Sen sijaan esitän että 200-luvulla havaittavan asutuksen harvenemisen taustalla on kaksi ilmiötä: toisaalta jo aiemmin alkanut maanomistuksen keskittyminen, ja toisaalta siirtymä liikkuvampaan maankäyttöön. Jälkimmäinen ilmiö on liitettävissä Petran kaupungin vaurauden ja väkiluvun alenemiseen seurauksena Rooman valtakunnan laajuisista taloudellis-poliittisista ongelmista, jotka johtivat kauppareittien pysyviin muutoksiin sekä valtakunnan jakoon v. 324. Näiden muutosten seurauksena Petran alueen talous lokalisoitui ja sen painopiste siirtyi kaupasta maanviljelyyn, jolloin Petraan ja sen lähikaupunkeihin syntyi historiallisista lähteistä todennettu suurmaanomistajien luokka. 400-luvulta eteenpäin maaseudun asutus heijastaakin lähinnä maanomistuksen keskittymistä. Vastaavia kehityskulkuja tunnetaan myös muista Bysantin keisarikunnan provinsseista myöhäisantiikin aikana.

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My work has been financially supported by the Research Foundation of the University of Helsinki, Jenny and Antti Wihuri Foundation, the Finnish Cultural Foundation, the Emil Aaltonen Foundation, and stipends from the FJHP. The research of the FJHP was carried out under the Academy of Finland's Center of Excellence in

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Helsinki, 30 May 2012,
Paula Kouki

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CHAPTER 1 – INTRODUCTION

1.1 Background and research parameters

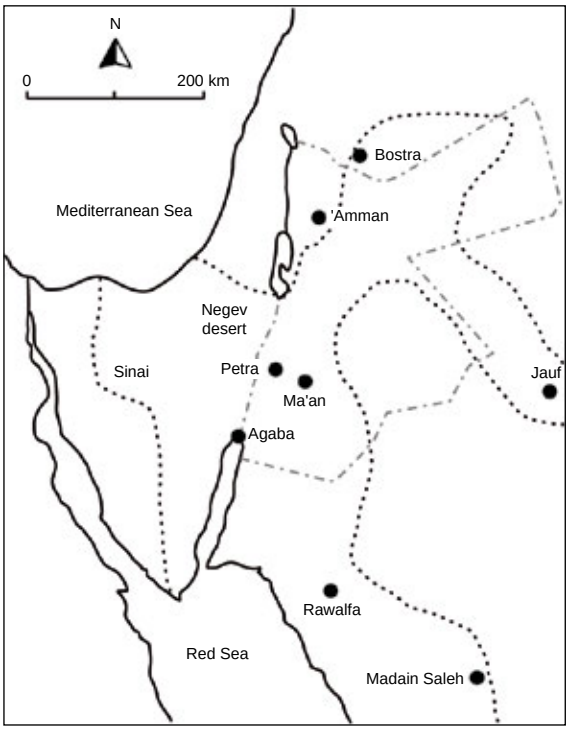
The Nabataeans lived as a nomadic people in the area of modern Jordan from at least the 4th century BC onwards. Their economic and political importance increased rapidly in the last centuries before the Christian era, reaching its zenith in the early 1st century AD. This development was accompanied by sedentarization and state-formation among the Nabataeans. At its largest, the geographical area ruled by the Nabataeans extended to the Negev and Sinai in the west and from Hawran in southern Syria to Mada'in Saleh in the Hijaz (Map 1). The basis of the Nabataeans' wealth lay in their participation in the long-distance trade from South Arabia to the eastern Mediterranean shores. The city of Petra was established at the crossroads of several caravan routes, and rapidly became an important centre for long-distance trade. The last centuries BC saw also the establishment of sedentary rural settlements in the Petra region after a hiatus since the end of the Edomite period.

It is now two decades since Zbigniew T. Fiema (1991) wrote his doctoral dissertation *Economics, Administration and Demography of Late Roman and Byzantine Southern Transjordan*, in which he made a careful analysis of the then known archaeological data from southern Jordan, from the Nabataean to the Byzantine periods. Until then, research in the Petra area had largely focused on the city itself and especially on excavations of its monumental buildings dated to the Nabataean-Roman period. Since the completion of Fiema's dissertation, a number of archaeological surveys carried out in the region have substantially increased the number of sites known in the hinterland of Petra. Moreover, a new source of information on the ancient city and its surroundings has come to light, namely the Petra Papyri, discovered in the Byzantine church in Petra in 1993.

Short updates, which include the recent research, have been made by Fiema (2002a) and by David Graf (2001a). Recently, Fawzi Abudanh (2006) made a contribution towards understanding the settlement patterns in the Petra region by analysing the settlement in the eastern parts of the area in his PhD dissertation *Settlement Patterns and Military Organisation in the Region of Udhruh (southern Jordan) in the Roman and Byzantine Periods*. However, with the body of archaeological data from the recent surveys, the new information available from the publications of the Petra Papyri (Frösén *et al.* 2002; Ar-

java *et al.* 2007; Arjava *et al.* 2011) and the conclusion of the fieldwork by the Finnish Jabal Harun Project, the time is ripe for a new, detailed analysis of the evidence for rural settlement and land use in the Petra region.

In this work, I model the spatial and temporal distribution of rural sites from selected archaeological surveys in the Petra region in order to establish the rural settlement patterns and site hierarchy in the region from the Nabataean-Early Roman period to the Byzantine–Early Islamic transition (2nd century BC–7th century AD). To begin with, the use of data from archaeological surveys as the primary material calls for acknowledging and rectifying the problems inherent in the data. The distribution of sites will then be considered by means of maps and statistics, using a division according to centuries rather than the conventional archaeological periods, in order to obtain a more detailed picture of the changes in rural settlement. In order to recognize changes in land use and land ownership from the survey archaeological record, I have adapted for the Petra region the model developed by Susan Alcock (1993) for explaining settlement change in Hellenistic through Late Imperial Greece.



Map 1. The largest extent of the Nabataean realm (after Kennedy 2000: 35).

Following the analysis of archaeologically recognizable settlement patterns, the role of environmental change, and climatic change in particular, in the settlement distribution will be critically considered. There are significant differences in the environmental conditions in different parts of the Petra region within relatively short distances, and the conditions for agriculture are marginal in most parts of the region. This suggests that climatic change, often postulated as a factor in the fluctuation of sedentary settlement in southern Jordan, has potential for explaining the phenomena recognisable in the archaeological data. My hypothesis is that climatic shift towards increased aridity should be reflected in the abandonment of agriculture and permanent settlement in the environmentally more marginal areas.

Finally, I consider the evidence of land use and landownership in the Nabataean realm and later province of *Arabia/Palaestina Tertia* as represented in ancient textual sources. For the Nabataean-Roman period, the main sources are the writings of Diodorus and Strabo, and the documents of the so-called Babatha archive (Papyri Yadin).

For the Byzantine period, valuable information is now available from the Petra Papyri, which indicate the existence of a wealthy landowning class in Petra in the 6th century AD. The papyri also imply that a process of the concentration of landholdings into fewer hands may have been ongoing within the region. The archaeological surveys have not, so far, produced evidence for large estates, a problem that will also be briefly addressed.

It should be stressed that this study does not attempt to be an exhaustive analysis of all the reasons behind the changes in rural settlement in the Petra region. I concentrate on just a few factors, namely the often-cited climatic and environmental change, as well as the influence of economic and social change, particularly the cessation of long-distance trade after the third century AD, and the influence of the landowning class, attested in the 6th century AD Petra Papyri. There are, however, likely to be several reasons behind the settlement and land-use changes observable in the archaeological record. These include factors such as the territorial reorganization of provinces (e.g., Fiema 1991: 115–16; Sipilä 2004; 2009) and wider-scale socio-political and economic processes in the Roman Empire as a whole (Fiema 1991: 106–15), which may have instigated changes at the local level. However, the view I have adopted in this work on the Petra region is a decidedly "bottom-to-top" one. My aim is to establish the settlement history of that particular region, and find out why that history might be different from that postulated for central and northern Jordan and Palestine for the same period.

The time span of this work covers the period from the foundation of the city of Petra and the establishment of the permanent settlement in the region in the last centuries BC to the early 7th century AD, when references to Petra in literary sources cease. This period encompasses many political changes in the region: the establishment of the Nabataean kingdom and its annexation by Rome in AD 106, the reorganization of the Roman provinces of *Palaestina* and *Arabia* in the 4th century, and finally the Muslim conquest of southern Jordan in AD 630.

The hinterland of Petra is here understood as the area roughly within a radius of 20 kilometres from the city (Map 2). This definition is based both on the suggestion about the extent of "Greater Petra" in Nabataean times (Lindner 1992a: 266), and on the fact that in the 6th-century Petra Papyri, Udhruh/Augustopolis and Sadaqa/Kastron Zadacathon appear to still have been under the jurisdiction of Petra, suggesting that, despite increasing regionalization, the Petra region formed a political and economic whole within the province of *Palaestina Tertia* until the end of the Byzantine rule.

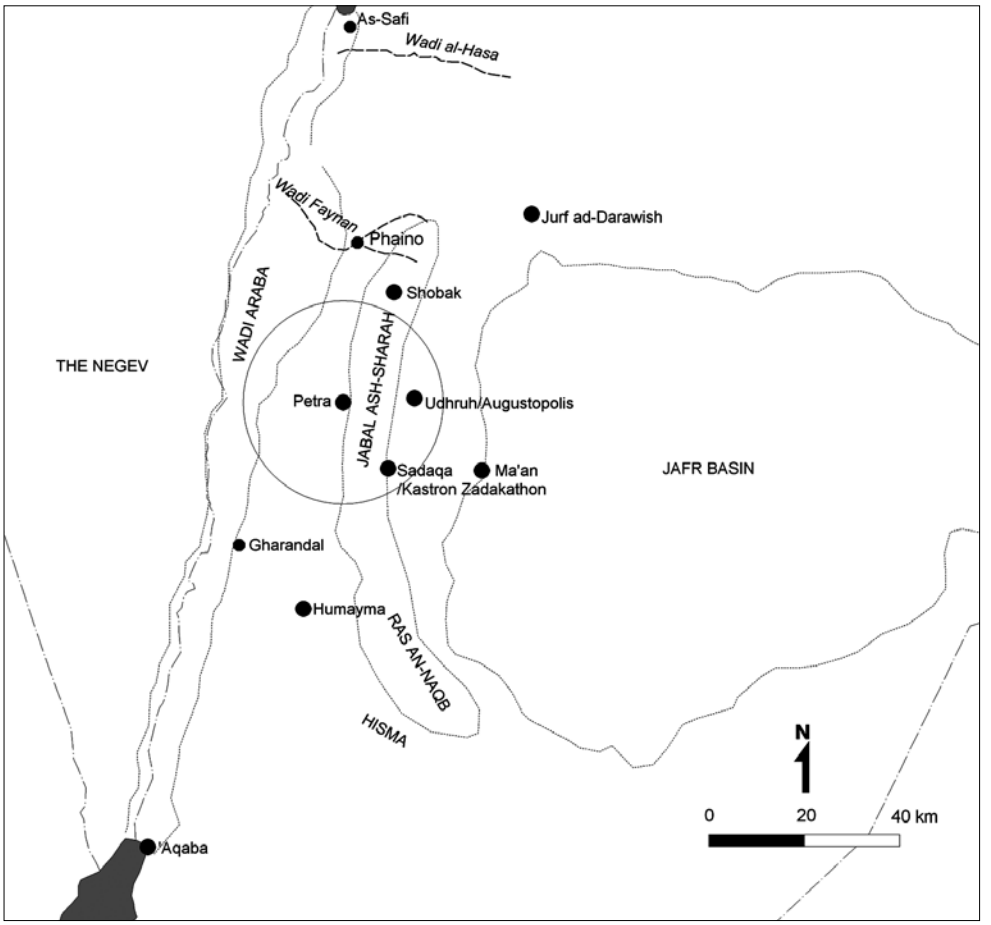
1.2 Summary of the contents

After this introductory chapter, the theoretical and methodological background of this work is discussed in Chapter 2. The chapter starts with a short introduction to the theoretical background, followed by a review of the earlier settlement studies in the Petra region. After that, the sources and methods for the review of climate and environmental change as a factor in settlement change are considered. The third part of the chapter concentrates on the methodology of analysing settlement patterns from archaeological

survey data. The potential sources of error in the analysis, inherent in the nature of archaeological survey data, are acknowledged and critically considered.

Chapter 3 presents the historical and archaeological background for the periods relevant for this work, based on archaeological and ancient textual evidence. Chapter 4 contains a review of the archaeological survey work conducted in the hinterland of Petra, divided into the pioneering work in the late 19th–early 20th century and the surveys from the 1970s onwards.

Chapter 5 presents current environmental conditions, which include topography, lithology and soils, climate and vegetation, and the factors influencing hydrology and erosion. The latter part of the chapter contains a brief review of available palaeoclimatic data and a tentative reconstruction of the palaeoclimate of southern Jordan. Chapter 6 gives a short introduction to the settlement history of southern Jordan from the Palaeolithic period to the Iron Age, concentrating on the Petra region, and with emphasis on the more recent periods.



Map 2. Southern Jordan with major sites and geographic regions mentioned in the text.

Chapter 7 consists of the detailed analysis of rural settlement patterns in the hinterland of Petra from the Nabataean-Roman period to the beginning of the Early Islamic period. The analysis is based on data from selected archaeological surveys, for which sufficient documentation was available. The first step of the analysis is the acknowledgement and rectification of the potential errors inherent in material combined from different surveys with variable methodologies and definitions. The settlement distribution, site size and site continuity are then explored with the resolution of a century rather than that of an archaeological period, to better elucidate gradual changes in rural settlement over time. After establishing the settlement patterns and site hierarchy, site size and settlement continuity in the Petra region are taken into consideration as archaeological evidence for changing land-use practices and landownership.

In Chapter 8, I return to the environmental explanation and discuss the potential influence of climatically forced environmental change for human settlement and agricultural pursuits. The research area is divided into four environmental zones characterized by different ecological conditions, and a hypothetical model for climatically driven settlement distribution change is presented. An overview of the archaeological evidence available for agricultural practices and cultivated crops in the Petra region is also presented. The settlement fluctuations, established in Chapter 7, are then reviewed through these environmental zones and compared with the palaeoclimatic record to observe whether or not climatic change could be the main factor stimulating settlement patterns during the period under consideration. Chapter 9 considers the evidence for agricultural practices and changes in landownership in ancient textual sources related to the time period.

The data and results obtained in Chapters 7–9 are summarized and critically discussed in the final chapter, Chapter 10. A new interpretation of the archaeologically observable settlement patterns is offered, underlining the importance of the local economic and social dynamics in rural settlement change in the Petra region from the Nabataean-Roman period to the Late Byzantine–Early Islamic transition.

Appendix I contains a catalogue of all sites included in the settlement analysis in a tabular format, with periods of occupation and short descriptions of the sites based on the original surveys, as well as references to the relevant literature where applicable. The unpublished information on the sites recorded by the Finnish Jabal Harun Project survey was available to me through participation in the project since 1999.

CHAPTER 2 – THORETICAL AND METHODOLOGICAL PERSPECTIVES

2.1 Theoretical and methodological background

The theoretical and methodological background for this work derives from two starting points. First, the time span under consideration is from the Classical through Late Antiquity, from which significant numbers of ancient textual sources are known, and second, archaeological survey data used as research material. Furthermore, this work should be seen as a contribution to the continuing debate on the settlement in the Petra region and southern Jordan and placed in the context of the earlier research on the subject, which will be discussed in Section 2.1.

Classical archaeology (here considered as the archaeology of both the Classical and Late Antique periods) originally developed independently of prehistoric archaeology, and from a different background (Trigger 1989: 35–36). Although the last decades have witnessed an increasing methodological and theoretical unification between prehistoric and Classical archaeology, particularly in the UK, North America and some Nordic countries, the developments in archaeological method and theory have not, to a great extent, penetrated into mainstream Roman or Late Antique archaeology, which still relies on the literary and art historical research tradition. However, a certain caution in the use of the interpretative tools designed for prehistoric archaeology can be considered justified, since their uncritical application may be inappropriate for a cultural zone where the interpretation is bounded by information from written sources (Lavan 2003: ix).

Although surveys have been carried out in the Eastern Mediterranean and the Near East at least since the late 19th century with the specific aim of mapping and documenting archaeological sites, archaeological field survey developed into an independent research method, alongside excavation, relatively late. The rise of field surveys is closely associated with the so-called 'New Archaeology', which later began to be termed 'processual archaeology'. In keeping with the overall research tendencies of processual archaeology, survey methodology was intensively developed in the 1970s and 1980s, with much effort put into questions such as adequate sampling strategies, site definition and interpretation of off-site find material (e.g., Keller and Rupp 1983; Cherry *et al.* 1991; Rossignol and Wandsnider, eds., 1992). At the same time, a change

of focus from regional surveys (e.g., Bintliff and Snodgrass 1988; Jameson *et al.* 1994) to the detailed examination of smaller geographical areas, such as an island (Cherry *et al.* 1991) or a valley (Barker 1995; Lloyd *et al.* 1997), took place in Mediterranean archaeological survey. The further development of archaeological survey theory and methodology is also closely tied to the development of landscape archaeology as an independent research paradigm (see, e.g., Barker and Lloyd 1991; Francovich and Patterson 2000). The proliferation of landscape archaeological survey projects has led to the increase in interdisciplinary multiperiod surveys in the Mediterranean area. The results of field surveys over the last 40 years have also revolutionized the view of the Classical and Late Antique countryside by overturning models based on textual sources and providing primary information about rural settlement (Bowden and Lavan 2004: xxii–xxv).

Although I would not call this work a study in landscape archaeology, its theoretical and methodological point of view is best understood in the context of the regional/settlement archaeology and landscape archaeological research tradition in the Eastern Mediterranean and the Near East. The line between these two has tended to blur, and indeed some researchers – mainly from the U.S. – see landscape archaeology only as a paradigm within regional archaeology (Kantner 2008: 55–59, while others consider the two to be more or less synonymous, a view that has a certain justification if we consider past 'regional' and 'landscape archaeological' survey projects in the Eastern Mediterranean and the Near East. From the European perspective, they are separate research paradigms, although related through the influence of regional studies in landscape archaeological practice.

In Britain and the Scandinavian countries, landscape archaeology was originally related to the study of historical landscapes, which were understood as palimpsests of past human activities. The concept of 'landscape' entered Mediterranean archaeology relatively late, in the 1980s, as a successor to regional/settlement archaeology (Wandsnider 2004: 53). The main difference between the site-oriented regional projects and landscape archaeology was the conception of the latter that instead of concentrating on certain locations, sites, human activity took place everywhere, which led to an interest in off-site distributions of archaeological materials (e.g., Cherry *et al.* 1991). Due to its interest in the distributions of sites and archaeological materials, the history of landscape archaeological research is also closely intertwined with that of the use of Geographical Information Systems (GIS). In the 1980s and 1990s, landscape archaeology was influenced by the *Annales* school of history, which brought Fernand Braudel's tripartite division of history into short events, medium time-scale cycles and long-term structures into archaeological interpretation (Knapp 1992). This led to what Wandsnider (2004: 53–56) calls *time perspectivism*, a view that has also influenced the approach I have chosen for the analysis of archaeological settlement in this work.

The post-processual critique from the 1980s onwards (see Shanks and Tilley 1987: 29–32; 46–56) was also aimed at landscape archaeologists' preoccupation with site distributions and GIS-based analyses. The core of the criticism was that archaeologists treated landscape as value-free, abstract space, which they viewed from the outside (Thomas 1993). Post-processual archaeologists demanded a more experiential

approach, emphasising the importance of people's perception and experience of the landscape, and stressing the individuality of that experience (Bender 1993). Within the last couple of decades, the growing popularity of social theory in European archaeology, especially in the United Kingdom and Scandinavian countries, has directed landscape archaeological research towards considering the social construction and meanings of archaeological landscapes (Ashmore 2007: 258–61), a tendency that can also be seen in some recent studies from Jordan (e.g., Reeves 2009). This discussion has, however, had relatively little influence on the practice of landscape archaeological fieldwork in the Mediterranean or the Near East so far (e.g., Wilkinson 2003; Barker *et al.* 2007a).

2.2 Previous research

The first systematic presentation of the distribution of Nabataean sites in the hinterland of Petra – or central Edom – was presented by Robert Wenning (1986) in his book *Die Nabatäer – Denkmäler und Geschichte*, in which he collected all the then available archaeological information about the Nabataeans within the area of the former Nabataean kingdom. The only systematic survey in southern Jordan at the time was the Wadi al-Hasa survey, the final results of which were not yet available. The information about the hinterland of Petra in Wenning's work was therefore still mainly based on Nelson Glueck's surveys in the 1930s, and it was not possible to form a systematic picture of the rural settlement.

The settlement patterns of southern Jordan in the Nabataean-Roman to Byzantine periods have been earlier analysed on a regional scale by Fiema (1991: 86–89, 116–18, 150–53, 217–35). Within the last decade, Graf (2001a) has briefly compared the evidence of rural settlement in different parts of Jordan through the Nabataean-Roman to Byzantine periods, and Fiema (2002a: 203–208) has presented a review of rural settlement in the Petra region based on the updated survey results. Most recently, Abudanh (2006) has considered the settlement patterns and military organization of the Udhruh region.

Fiema (1991: 88–97) noted a three-level settlement hierarchy during the Nabataean-Roman period. The urban centre was represented by Petra, below which there were intermediate-level towns or large villages on the major trade routes. His lowest level of hierarchy consisted of the numerous agricultural villages, hamlets and farmsteads, the majority of which were in the Petra region located west of the Via Nova Traiana. No immediate change could be observed after the annexation, which, according to Fiema, was to be expected, since the economy remained based on trade and commerce. However, he noted a withdrawal of settlement from the outlying areas in the later part of the Roman period. Fiema (1991: 235–39) also noted that the Byzantine period witnessed expansion of settlement in certain areas, such as the environs of Udhruh, while the formerly densely populated ash-Shara area experienced a decline in site density. He related these changes to the regionalization and limited exchange of goods after the cessation of long-distance trade through the Petra region, and the resulting lack of economic and political significance of the area in the concerns of Constantinople.

In a more recent article, Fiema (2002a: 203–208) briefly reviewed the settlement in the hinterland of Petra in the light of the results from the archaeological surveys of the 1990s. However, the picture was not greatly different from the one already presented in his dissertation: the most numerous archaeological remains were related to the Nabataean-Early Roman period, followed by a subsequent decrease in the number of sites in the Late Roman and Byzantine periods, and a change of the focus of settlement from the Jabal ash-Shara area eastwards, i.e., to the surroundings of Udhruh.

In a short article, Graf (2001a) reviewed the data available from archaeological surveys in different parts of Jordan, considering it as evidence of rural settlement. He made no distinctions according to site function, but used the reported total numbers of sites from different periods, which, as he himself comments, may cause some bias in the results. In all the areas, the Nabataean-Early Roman sites were predominant, followed by a drop in the Late Roman period, and a regeneration of rural sites in the Byzantine period. For the area south of Ghors, i.e., the highlands and the Hisma, the data available in the late nineties was still meagre, but Graf concluded that although the rise in the number of sites in southern Jordan during the Byzantine period was much less significant than in the northern parts of the country, there was still *"a healthy proportion of Roman and Byzantine sites comparable to other regions"* (Graf 2001a: 472). Graf also considered land use in terms of evidence of centuriation, rural markets, villas and imperial estates in the epigraphic, historical and archaeological sources.

In his dissertation *Settlement Patterns and Military Organisation in the Region of Udhruh (southern Jordan) in the Roman and Byzantine Periods*, Abudanh (2006) concentrated on the settlement and military/security installations in the eastern periphery of the Petra region, including the eastern parts of Jabal ash-Shara. His results of the settlement history agree with those of Fiema. The Nabataean period is characterized by the most intensive settlement and land use, and there is no significant change after the annexation. A considerable decline in settlement took place in the Udhruh region in the Late Roman period (3rd century AD), which Abudanh (2006: 210–11) does not really attempt to explain beyond broadly referring to the economic and security problems of the Roman Empire. This is followed by a recovery in rural settlement and agriculture in the Byzantine period, with the extension of settlement and cultivation into the pre-desert zone. Abudanh (2006: 244–49) suggests this may already have taken place in the Nabataean period, even though archaeological evidence is lacking. Settlement remained relatively constant into the 7th century, but many of the sites appear to have been abandoned by the 8th century. Abudanh (2006: 245–47) considered the possible role of military and security arrangements in the settlement changes, but conceded that it did not seem to play a major part. Instead, he found agricultural pursuits as the major reason for settlement in the region, and explained these with both the economic ties to Petra and the increasing political and economic importance of Udhruh from the Late Roman period onwards. He also suggested that the Early Islamic decline in rural settlement reflects the increased shift of the population to a seminomadic way of life as a result of the loss of markets for agricultural products due to the decline of Petra, and the possible influence of the cultural change related to the adoption of Islam (Abudanh 2006: 224–25).

2.3 Environmental studies

It has been suggested by several scholars (e.g., Hart and Falkner 1985: 268; MacDonald 2001; Fiema 2006: 82) that environmental change, triggered by climatic oscillations or human land use, might play an important role in settlement changes in the Petra region. However, to my knowledge, no one has really tried to explore this possibility beyond Burton MacDonald's (2001) brief overview comparing the evidence of past climate and settlement in southern Jordan. Nevertheless, considering the marginal environments of the Petra region, the supposition that environmental change may be a factor behind the settlement and land-use changes is reasonable and worth serious consideration.

Relatively little palaeoenvironmental research has been carried out in the Petra region, and so far that has almost exclusively concentrated on the prehistoric periods (Field 1989; Fish 1989; Gebel 1992), with the exception of the work of Patricia Fall (1990). The palaeobotanic studies from excavations of the Classical and post-Classical period are largely concentrated on dietary reconstructions (e.g., Karg 1996; Jacquat and Martinoli 1999; Tenhunen 2001). This situation, which is a common problem for archaeological studies on environmental change, necessitates the use of available contemporary environmental data about vegetation, soils and climate to represent the past. Arguably, this approach can lead to misinterpretations since landscapes change over long periods of time. However, the climatic regime, as well as the climatic and topographic controls over the distribution of rainfall, and therefore the controls over vegetation and soil formation, have remained largely the same in the Petra region from the period under study until the present, and thus it is considered that the present-day information adequately represents the broad environmental conditions in the past.

Lithological maps at a scale of 1:50,000 were not available for the whole region, and therefore Friedrich Bender's (1974) work on the geology of Jordan was used for inferring the lithology of the eastern parts. The only soil map available for the Petra region is at the scale of 1:250,000 (Royal Jordanian Geographic Centre 1995) and it is mostly based on recognizing the soils on Land-Sat images rather than on field observations (Jordan Soils & Land Management 2006). Thus, it does not give very detailed – or necessarily, completely reliable – information about the soils. The information on the rainfall distribution and characteristics in southern Jordan is mainly based on the article by Numan Shehadeh (1985). More detailed information about rainfall was available from two stations of the Meteorological Department of the Hashemite Kingdom of Jordan, namely Wadi Musa and Ma'an (Meteorological Department, The Hashemite Kingdom of Jordan 2004). The article by Dawud M. al-Eisawi (1985) was used as the main source on natural vegetation, complemented by the research by Ingrid Künne and Margarete Wanke (1997) in the Petra region. Recently, Jacques Besançon (2010) has provided a thorough overview of the environments of different geographical areas of the Petra region.

The limited availability and low resolution of environmental data is not suitable for a detailed, GIS-based environmental analysis. The environmental setting of the sites is therefore modelled using relatively wide agro-ecological zones (FAO 1996) rather than

considering the settings of individual sites by the means of GIS. However, because the objects of interest were the regional changes in settlement over time rather than the environmental conditions at individual sites, this resolution of data was deemed adequate.

2.4 Methodology

Problems of survey data

When working with material from archaeological surveys, it needs to be acknowledged that there are problems in using survey data: those which are inherent in the nature of the archaeological material itself – which I call here "objective constraints"– and those introduced by the survey methodology and further processing of the material, here called "interpretative constraints." It is not always straightforward to separate these, since taphonomic and material-related factors may introduce challenges for methodology and interpretation.

Objective constraints

It is universally recognized that various taphonomic factors, i.e., those affecting the preservation of archaeological sites and materials, can influence surface survey results. Erosion can destroy or obscure archaeological sites by transporting the materials or through the burial of the site (Waters and Kuehn 1996: 484–85; Banning 2002: 46–47, 72–73). The degree to which the surface material represents the subsurface archaeology can also vary greatly (see Barker 1991: 5; Cherry 1983: 398–99; Gaffney 2000), resulting in problems in estimating the site size, chronology and function (Cherry 1983: 379; Gill *et al.* 1997: 67). Evidence of earlier periods may be buried under later settlement or a later, intensively settled period may obscure earlier periods of less intense settlement, which can therefore go unrecognized in a surface survey. There are examples where only earlier material has been found on the surface of a site, but excavation has revealed that the site also has later phases of occupation (Schick 1994: 136–37). These problems are more acute with large, long-lived sites with deep archaeological deposits – small, shallow sites are less likely to contain significantly different materials under the surface, but they are more likely to suffer from the erosion of materials.

Later land use may also destroy or obscure archaeological evidence. In the Petra region, many traditional villages are still in the same locations as their predecessors in the Classical and Islamic periods. The continuing reuse of structures can mask some periods of activity, especially as can be observed by a surface survey. The common practice of reuse of building materials and ancient structures, which is well documented in the Petra region and appears to have taken place throughout its history (e.g., 'Amr *et al.* 1998: 521, 526; 'Amr and al-Momani 2001: 267), is likely to lead to the degradation and even obliteration of archaeological remains even at places where the original site is not covered by later occupation. Furthermore, the intensive land use of the modern

period, with the unprecedented growth of settlements, construction work, and use of natural resources, forms a constant threat to the preservation of archaeological remains.

Another problem is the variable preservation of archaeological materials, particularly pottery, from different periods. A combination of processes may increase the proportion of coarse wares in a surface collection and thus cause bias towards more durable sherds. Prehistoric ceramics are usually less resistant to degradation, as their firing temperature has been low. If exposed on the surface, they will therefore be rapidly destroyed by trampling and erosional processes (Malone and Stoddard 2000: 96). The problem of degradation is not limited to prehistoric pottery. It has been noted in the Finnish Jabal Harun Project survey that the Byzantine ware is less durable than the Nabataean ware, which is likely to cause the under representation of the former in a surface collection, and especially in the number of diagnostic sherds.

The availability and use of pottery and other materials can also influence the archaeological visibility of a cultural period. The amount of pottery in use and the rate of its deposition in the landscape may vary during different archaeological periods depending on such factors as the economic situation, how valuable pottery was regarded and for what purposes it was used (Alcock *et al.* 1994: 141; Malone and Stoddart 2000: 101). The land-use practices during a certain period also affect the visibility of that period in the archaeological record. Extensive forms of land use, such as herding, leave few archaeologically detectable traces. This problem is particularly emphasized in the study of mobile populations, who often use little pottery because it is impractical due to its weight and fragility. Finally, the archaeological periods recognized as chronologically longer are likely to be better represented in the survey material whereas a short period is likely to leave respectively less archaeological evidence.

Interpretative constraints

The above-mentioned problems aside, an entirely new set of difficulties arises when data from different surveys is being used and compared. These problems stem from the methodological differences in fieldwork, variable definitions of sites, chronological definitions used and the detail – or rather, the lack of it – of published data.

There is an extensive literature on survey methodology, the identification of sites and the interpretation of artefact scatters (e.g., Keller and Rupp 1983; Rossignol and Wandsnider 1992; Francovich and Patterson 2000; Banning 2002), and there is no need here for an extensive discussion. However, it is necessary to recognize that survey methodology and sampling strategies may introduce a bias in the find material and types of sites found by the survey (Barker 1991: 3–5; Mattingly 2000). A central problem of survey data is its representativeness. Archaeologists seldom have the opportunity to exhaustively survey every part of their research area. Rather more common are various techniques of sampling to choose parts of the research area that can be considered to be representative of the area as a whole (Cherry 1983; Mattingly 2000), or prospecting for archaeological remains by using aerial photographs before actually

going into the field (e.g., Tholbecq 2001; MacDonald *et al.* 2004; Kennedy and Bewley 2009). Thus, in short, the choice of survey methods results in variable resolutions of the data produced, which constitutes a problem when the results from different surveys are compared.

The whole concept of *site* is problematic. The definition of a site is always subjective, and different archaeologists and research traditions use different criteria for what is called a *site* (Dunnell 1992: 22–33; Fentress 2000: 48–49). In survey reports, it is seldom explicitly stated how the sites have been defined, which introduces an element of uncertainty and potential error into the use of the results. Survey results are most often presented as numbers of sites dated to each archaeological period. However, the number of sites alone can give a misleading picture of the settlement and activity in an area, unless information on the types and sizes of the sites is also available. It should also be borne in mind that human activity does not just concentrate on certain isolated points (sites), but that there are a wide variety of activities that take place outside these specific locations, and archaeological materials cover the landscape in a more or less continuous manner. Non-site or off-site survey (Foley 1981; Rhoads 1992; Dunnell 1992: 33–36) attempts to take into consideration the whole of this evidence to form a comprehensive picture of the past human activities that have taken place in the landscape.

There are also problems concerning the archaeological material that forms the source of the interpretation and dating of a surveyed site. A central problem is the low temporal resolution of the data acquired by field walking (Cherry 1983: 379). Most often sites are dated only by the surface collection of pottery, which is subject to many sources of error (Millett 2000; Malone and Stoddart 2000). The dating of pottery is usually based on excavated pottery stratigraphies, and where detailed stratigraphy is not available, it is difficult to date finds more accurately than to a certain period. The identification of pottery is usually based on diagnostic elements which are often less frequent in surface collections (Rutter 1983: 137–38; Malone and Stoddard 2000: 95). The precision of the pottery-based dating is also variable. As an example, Nabataean fineware styles can be dated with an accuracy of decades (Schmid 1996), but usually the accuracy of dating based on surface pottery is within the range of a century at best (Cherry 1983: 379). Common ware types are more difficult to identify and date due to little stylistic variation. The styles also tended to change less quickly in the common wares and may have overlapped considerably (Millett 2000: 54–57; Schick 1994: 137; Gerber and Fellman Brogli 1995). Particularly the pottery of the late 2nd and 3rd centuries AD[1] and the transitional forms from the Late Byzantine to the Early Islamic period (6th–7th centuries) have so far been poorly known in the Petra region, and are therefore difficult to date (Fiema 2002a: 203).

It is generally acknowledged that recording off-site pottery densities gives important information on land-use practices (Bintliff and Snodgrass 1988; Wilkinson 1988; Alcock *et al.* 1994). However, notwithstanding the intensive part of the FJHP survey, which only covers Jabal Harun and its immediate vicinity, the archaeological surveys in the Petra region published to date have been site-oriented and surface arte-

[1] I am grateful to Ms. Yvonne Gerber for this observation.

fact densities have not been systematically documented or reported in any of them.[2] The lack of systematic and intensive multiperiod surveys means that our understanding of many archaeological periods in the Petra region is still patchy at best. Furthermore, sites without large structures, such as nomadic camps or lithic and pottery scatters, are unlikely to be found in an extensive survey, which relies heavily on the visibility of sites. The Prehistoric and Islamic periods have been especially underrepresented in the archaeological research on the Petra region, and therefore, the archaeological data and information concerning these periods can also be expected to be missing. For the periods under consideration here, the situation can be considered better, but even so, the almost complete disregard for off-site artefact densities in earlier surveys means that a potentially important source for land-use practices is absent for the Petra region.

A major problem regarding the use of survey data for any closer analysis of settlement patterns is the variable detail of publication, even with regard to a single survey. The problem with especially the 1980s surveys in the Petra region is the insufficient detail in, or outright lack of publication of the results. On the other hand, only preliminary reports are often available for the later surveys, and those are seldom detailed enough to enable closer analysis of the sites.

The challenge of comparing data from different surveys is further enhanced by the fact that the surveyors rarely explain how they date the archaeological periods in their publications. There are different ways of dividing historical periods, and the border between the Roman and Byzantine periods especially is ambiguous. For example, the Byzantine period can be considered have already begun with the foundation of Constantinople in AD 330, or date from the division of the Roman Empire in AD 395 or even the fall of Rome in AD 476 (Cameron 1993: 7–8). Thus, depending on which date is chosen, the beginning of the Byzantine period can vary by more than a century. Likewise, Late Roman can mean the period from the 2nd to the 4th centuries AD, but seems to be often used to denote particularly the 3rd century, while the 4th century can also be included in the Byzantine period. A further complication is the use of 'Nabataean' as both a cultural and a chronological marker, as 'Amr *et al.* (1998) and Abudanh (2006) have done.

Settlement analysis

My analysis of rural settlement in the hinterland of Petra is mainly based on a sample of sites from three recent archaeological surveys and the interpretation of the settlement patterns reflected in these data. It can be expected that if there are regional phenomena recognizable in the settlement data over time, they should be reflected in the data from the different surveys.

Due to the problems inherent in the archaeological survey data, illustrated above, it is necessary to begin the analysis by acknowledging the limitations of the data. To overcome and rectify these problems, a careful consideration is given to the classifica-

2 The situation is about to change when the results of the Brown University Petra Archaeological Project's survey in the Ras Slaysil – Bayda area become available.

tion of sites as settlements and their division into size categories, as well as the equalization of the variable chronologies used in the different surveys. After defining the classification and size hierarchy of sites, I examine the spatial and temporal changes in rural settlement and site hierarchy through distribution maps and statistics.

To recognize potential changes in land use and landownership in the archaeological survey data, I have adapted for the Petra region the model developed by Alcock (1993) in *Graecia Capta* for the Classical through the Roman Imperial period in Greece. Alcock based her model on a substantial body of data collected from numerous archaeological surveys in Greece. She interpreted the initial phase of dispersed rural settlement, characterized by the increase in the number of small sites (single farmsteads) during the Classical and Early Hellenistic period, as a sign of private ownership of land and intensification of cultivation. Along the same lines, she then convincingly argued that the drop in the numbers of rural sites, particularly the single farmsteads, combined with the increased discontinuity of sites and the nucleation of settlements into larger units during the Late Hellenistic and Early Roman periods, were symptoms of the concentration of landownership and the formation of large estates owned by a wealthy elite. According to her, this development finally culminated in the emergence of *villa* establishments during the early Roman Imperial period. Moreover, she also proposed that the concentration of agricultural land into larger estates led to a shift from intensive small-scale agriculture to more extensive modes of cultivation and land use. This change is reflected in the archaeological record from the surveys by the lack of off-site pottery from the Roman period (Alcock 1993: 48–49, 55–63, 71–80, 85–88).

It can be argued that the adaptation of a model intended for Classical and Roman Greece to another geographical region, with different environmental constraints and land-use traditions, and within a different time frame, is not free of problems. For example, actual *villae* are not known in the Petra region or, indeed, in most of the province of Arabia (Graf 2001a: 228–29). However, it is considered that although the phases and underlying reasons of the process may differ, the essential signs of the concentration of landed properties in the archaeological record, namely the disappearance of small sites and the nucleation of settlement, can be expected to remain the same. Therefore, Alcock's model offers a useful point of departure for recognizing changes in landholding systems on the basis of survey data. It should be stressed that I do not attempt to replicate Alcock's research in Greece in its entirety for the Petra region, but I am instead using the core ideas of her analysis – the phenomena of settlement distribution, nucleation and continuity – as a tool to explain settlement changes in the archaeological record.

After establishing the settlement patterns observable in the archaeological data, I consider the environmental and historical constraints influencing rural settlement in the hinterland of Petra. I present a hypothetical model of the influence of climatic change towards more aridity on the rural land use and settlement in the Petra region, which I divide into four environmental zones according to their agro-ecological potential (FAO 1996). Then I test the model by plotting the sites against the defined environmental zones, to establish whether a shift towards more arid climatic conditions could be a dominant factor in the temporal and spatial changes in the distribution of

rural sites. I also consider the available historical data concerning land use and land-ownership in the Petra region, and compare it to the archaeological model of rural settlement change, to see how the political, economic and social changes documented in the historical sources are reflected in the archaeological material. Finally, I present an interpretation of the rural settlement change in the hinterland of Petra based on archaeological, environmental and historical sources.

Chronological considerations

In this work I use a modified chronology, which broadly follows the chronology for Jordan proposed by Homès-Fredericq and Hennessy (1986), but I have rounded the conventional archaeological periods to the nearest century (see Table 1). The pottery-based dating of most archaeological sites is more suitable for such a division, because the accuracy of dating of survey pottery for these periods is generally within a century, and archaeological materials seldom rapidly reflect the historical events signifying the boundaries of archaeological periods.

The representation of archaeological materials as a set of chronological distribution maps can be criticized, because the maps are by necessity static and do not allow the illustration of temporal dynamics (Cherry 1983: 379). For example, if all the Nabataean-Roman period sites were represented on the same map, the map would include sites from the 2nd century BC to the 2nd or even 3rd century AD, depending on the chronological division used, covering a period of 400–500 years. Although it is obvious that not all the sites would be occupied simultaneously over such a long period of time, a map like this would create the illusion of that, and settlement dynamics over centuries would go utterly unnoticed. To overcome – or at least, to reduce – this problem, and to enable the recognition of gradual change in the rural settlement patterns, I decided to use a more detailed temporal division, supported by the availability of closely dated pottery stratigraphies for the Nabataean-Roman and Byzantine periods in the Petra region, and observe changes in rural settlement by a century rather than by an archaeological period.

Table 1. The conventional dating of relevant archaeological periods in Jordan after Homès-Fredericq and Hennessy (1986) and the modified chronological division used in this work

PERIOD	CONVENTIONAL DATING	MODIFIED DATING
Hellenistic	332 – 63 BC	300 BC – 100 BC
Nabataean-Early Roman Late Roman	63 BC – AD 106 AD 106 – 324	100 BC – AD 100 AD 100 – 300
Early Byzantine Late Byzantine	AD 324 – 491 AD 491 – 634	AD 300 – 500 AD 500 – 600
Islamic	AD 634 onwards	AD 600 –

CHAPTER 3 – HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

3.1 The Nabataean period

The earliest sources[3] mentioning the Nabataeans are the writings of Hieronymus of Cardia in the early 3rd century BC. Hieronymus described the unsuccessful military expedition of Athenaeus, a general of Antigonus of Syria, against the Nabataeans in 311 BC.[4] The original text is lost, but the description is preserved in the mid-1st-century BC *Bibliotheca historica* of Diodorus Siculus (Hackl *et al.* 2003: 429–31). In the well-known description, the Nabataeans are depicted as nomadic sheep and camel herders, forbidden to cultivate land or build houses under the penalty of death:

> *They live in the open air, claiming as native land a wilderness that has neither rivers nor abundant springs [...] It is their custom neither to plant grain, set out any fruit-bearing tree, use wine, nor construct any house; and if anyone is found acting contrary to this, death is his penalty.* (Diod. 19.94.2–3)

Elsewhere Diodorus describes the areas where the Nabataeans live and mentions that they lead a life of brigandage:

> *This land [Arabia] is situated between Syria and Egypt, and is divided among many peoples of diverse characteristics. Now the eastern parts are inhabited by Arabs, who bear the name of Nabataeans and range over a country which is partly desert and partly waterless, though a small section of it is fruitful. And they lead a life of brig-*

[3] Only the major literary and documentary sources relevant for this work are discussed here. A collection of ancient textual sources related to the Nabataeans, including inscriptions and papyri, and with commentaries, can be found in *Quellen zur Geschichte der Nabatäer* (Hackl *et al.* 2003). The historical sources concerning Late Roman and Byzantine Petra have been reviewed by Fiema (2002a: 192–95) and the Byzantine and Early Islamic sources concerning southern Jordan have been discussed by Schick (1992, 1994). An overview of the Byzantine ecclesiastical sources concerning Petra has also been presented by Schick (2001).

[4] The campaign is commonly dated to 312 BC, but it has been recently proposed that the date should rather be 311 BC (see Wenning 2007: 28).

> *andage, and overrunning a large part of the neighbouring territory they pillage it, being difficult to overcome in war.* (Diod. 2.48.1–2)

On the other hand, the Nabataeans are also reported to be wealthy merchants involved in the trade of aromatics and asphalt:[5]

> *While there are many Arabian tribes who use the desert as pasture, the Nabataeans far surpass the others in wealth [...] for not a few of them are accustomed to bring down to the sea frankincense and myrrh and the most valuable kinds of spices, which they procure from those who convey them from what is called Arabia Eudaemon.* (Diod. 19.94.5–6)

> *And a large lake is also there which produces asphalt in abundance, and from it they derive not a little revenue.* (Diod. 2.48.6–7)

> *The barbarians who enjoy this source of income take the asphalt to Egypt and sell it for the embalming of the dead [...]* (Diod. 19.99.3)

Some of the tribes of Arabs also cultivate land, although they do not build houses, that is, they lead a seminomadic way of life:

> *There are also other tribes of Arabs, some of whom even till the soil, mingling with the tribute paying peoples, and have the same customs as the Syrians, except that they do not dwell in houses.* (Diod. 19.94.10)

The following description of people around the Gulf of Aqaba (Laeanites Gulf), who are also called Nabataeans, suggests that there were also settled Nabataeans:

> *[...] the Laeanites Gulf comes next, about which are many inhabited villages of Arabs who are known as Nabataeans. This tribe occupies a large part of the coast and not a little of the country which stretches inland, and it has a people numerous beyond telling and flocks and herds in multitude beyond belief.* (Diod. 3.43.4–5)[6]

Diodorus also mentions that in the land of the Nabataeans there is a certain "rock" *(πετρα)*, where they store their valuables and to which they withdraw for safety. This is mentioned both in Diod. 2.48.6 and in the description derived from Hieronymus of Cardia about the military expedition to Petra (Diod. 19.95.1–2).[7]

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[5] Diodorus keeps repeating information: the description of the Dead Sea in the story of the campaign against Nabataeans (Diod. 19.98) is almost word for word the same as the one already given in Diod. 2.48.7–9.

[6] The same description can be found in Strabo (16.4.18).

[7] It has been suggested that the place meant is Umm al-Biyara, the mountain close to the city of Petra, where remains of both the Edomite and the Nabataean period have been found (Horsfield and Horsfield 1938–39). Some scholars have also postulated that the "petra" of Hieronymus does not refer to the loca-

The information about the settled Nabataeans around the Laeanites Gulf (Gulf of Aqaba) in Diod. 3.43.4 and the desert-dwelling brigands in Diod. 2.48.1–2 or the pastoral (semi-)nomads in Diod. 19.94.2–3 seems to be somewhat contradictory. It should be noted, however, that the mentions of Nabataeans are scattered in three different parts of Diodorus' work, and they represent information drawn from different sources (Hackl *et al.* 2003: 27–31; 430–31). Furthermore, as some scholars have pointed out (e.g., Graf 1990: 53), the prohibitions on agriculture and the construction of houses, as well as the Nabataeans' love of freedom, follow the literary tradition of the description of nomads in antiquity. In Greek and later Roman literature, a nomad was also practically a synonym for a barbarian (Shaw 1982/1983), that is, a non-Hellene or a non-Roman.

It has also been argued that there is a discrepancy between the description of the Nabataeans as nomadic pastoralists and the successful and wealthy merchants in the description from Hieronymus of Cardia in Diodorus (Dijkstra 1995: 301–302). However, Hieronymus' description conforms, in fact, with ethnographic data about nomadic societies in historical times, who frequently engage in trade (e.g., Khazanov 1994: 70). As nomadic pastoralists, the Nabataeans were exceedingly well equipped to take the role of middlemen in the caravan trade after the Lihyanites lost their dominant position in the area in the early 4th century BC (see Nehmé *et al.* 2006: 50 with the references). What began as a complementary activity grew to be the major occupation when the demand for luxury products increased in the Mediterranean area with the rise of the power of Rome. It can be argued that the acquisition of wealth and contacts with sedentary peoples led to an increasing social complexity as well as a need for a permanent "power base." This in turn, led to the establishment of the Nabataean kingdom with its centre in Petra, which was already the political and religious centre of the Nabataeans, and the beginning of sedentarization starting with the elite (e.g., Wenning 2007: 29–31; see also Friedman and Rowlands 1982: 233–34; and the discussion in Fiema 1991: 47–54).

While most scholars today date the beginning of the Nabataean sedentary settlement and agriculture to the late 2nd–early 1st centuries BC (Stucky 1996: 14–17; Schmid 2001: 370–71; al-Salameen 2004: 134), earlier scholarship maintained that the Nabataeans only became sedentary in any significant numbers, and started practising agriculture, in the 1st century AD. This view has generally been based on the conception that the international trade through Petra already ceased around the end of the 1st century BC, or in the 1st century AD at the latest, and that the Nabataeans only resorted to agriculture when the revenue from trade was lost (Bowersock 1983: 64–65; Negev 1986: 45–46; Knauf 1986: 80; see also the critique in Fiema 2003: 39–43). The most extreme suggestion is that the sedentary settlement and agriculture in southern Jordan were originated by other, sedentary tribes from the north, or people from the Mediterranean sphere (Knauf 1986: 76). On the other hand, there are also those who propose

tion of the later Nabataean capital, but to Sela, near Tafila, north of Petra (Zayadine 1999; Wenning 2007: 27–29). However, the discovery of archaeological evidence of settlement in Petra already in the 3rd century BC supports the identification of Petra with Hieronymys' Petra.

that the sedentarization of the Nabataeans took place much earlier, already in the 4th century BC (Dijkstra 1995: 301–302).

The earliest archaeological evidence of settlement in Petra has now been firmly dated back to the 3rd century BC. These earliest excavated structures are apparently domestic, and the settlement was probably restricted to a relatively small area on the bank of Wadi Musa around the area of the later Qasr al-Bint (Graf 2007a; Mouton *et al.* 2008; Parr 2007: 278–80; cf. Parr 1960: 135). Finds of Hellenistic pottery and coins can be associated with these structures (Parr 2007: 282–83).

The first known Nabataean ruler is Aretas, in 168 BC (II Macc 5:8).[8] After his reign there is a gap in the record, but beginning with the reign of Aretas II (120/10–96 BC), eight or nine Nabataean kings are known from literary sources, coins and inscriptions (see, e.g., Hammond 1973: 15–39). Rather than an autocratic kingdom, Nabataea was most likely a confederation of tribes under the rulership of one tribe or group – the Nabataeans – and it was not ethnically or culturally homogeneous (Knauf 1986; Graf 2004). A distinctive Nabataean material culture, which starts with coins and pottery following Hellenistic examples, developed in the late 2nd–early 1st centuries BC (Schmid 2001: 368, 371–73).

The Nabataeans are mentioned on several occasions in Flavius Josephus' 1st-century AD works *Antiquitates Iudaicae*, which is a history of the Jewish people based on earlier sources, and *Bellum Iudaicum*, which describes the suppression of the Jewish revolt by the Romans in AD 66–73. Josephus' histories illustrate the contest for power between the Nabataeans and the Seleucids in the 1st century BC (e.g., Josephus *Ant. Iud.* 13.13.3–5, 13.14.2, 13.15.1–2; *Bell. Iud.* 1.4.3–4, 1.4.7–8), the political involvement of the Nabataean kings in the affairs of Judaea (e.g., Josephus *Ant. Iud.* 15.4.4–5.2, 15.6.2–3; *Bell. Iud.* 1.19.1–3,) and their position as client kings (or friendly kings) to Rome in the 1st century BC–1st century AD (e.g., Josephus *Ant. Iud.* 14.8.1; *Bell. Iud.*1.19.3, 1.19.5–6, 1.20.4, 2.5.1–3).

The Seleucid Empire (Syria) was annexed by Rome in 64 BC, which made Nabataea the neighbour of the expanding Roman state, and brought the Nabataeans into direct contact with Romans (e.g., Josephus, *Ant. Iud.* 14.2.3, 14.3.3–4; *Bell. Iud.* 1.6.2–5, 1.8.1, 1.8.7–9). It was in the interest of Rome to also pacify the governments of the neighbouring regions. Judaea became a client kingdom a year later, and it seems that the king of the Nabataeans likewise became one of these so-called "friendly kings" (Bowersock 1983: 30-31, 54-56). Although Judaea was annexed in AD 6, Nabataea remained a client kingdom for another century.

The Greek geographer Strabo wrote about the Nabataeans in his *Geographica*, written probably around the end of the 1st century BC. Although Strabo relied partially on earlier literary sources, he also had more up-to-date information concerning Nabataea, which he had acquired through his friends, the philosopher Athenodorus of Tarsus, who had visited Petra, and Aelius Gallus, who was a prefect in Egypt and who had been in charge of an unsuccessful expedition to *Arabia Felix* (South Arabia) around 25 BC

[8] A mention of the Nabataeans and a king of Arabs in a fragmentary Greek epigram by Poseidippos of Pella is sometimes held as evidence for kingship among the Nabataeans as early as in the 3rd century BC, but this conclusion is questionable (see Hackl *et al.* 2003: 586–87).

(Hackl *et al.* 2003: 598, 604–606). Strabo describes Petra as follows:

> *The metropolis of the Nabataeans is Petra, as it is called; for it lies on a site which is otherwise smooth and level, but it is fortified all round by a rock, the outside parts of the site being precipitous and sheer, and the inside parts having springs in abundance, both for domestic purposes and for watering gardens.* (Strabo 16.4.21)

He gives information on the buildings and agricultural matters:

> *Their homes, through the use of stone, are costly; but, on account of peace, the cities are not walled. Most of the country is well supplied with fruits except the olive; they use sesame-oil instead. The sheep are white-fleeced and the oxen are large, but the country produces no horses. Camels afford the service they require instead of horses.* (Strabo 16.4.26)

The customs and the society of the Nabataeans are also described by Strabo:

> *The Nabataeans [...] are so much inclined to acquire possessions that they publicly fine anyone who has diminished his possessions and also confer honours on anyone who has increased them. Since they have but few slaves, they are served by their kinsfolk for the most part, or by one another, or by themselves; so that the custom extends even to their kings.* (Strabo 16.4.26)

Although excavations of private buildings have so far been few in Petra, in the light of the available archaeological evidence, it seems that before the late 1st century BC, the settlement in Petra was relatively modest and restricted in area, and it incorporated both sedentary and more temporary elements (Stucky 1996: 14–17; Zeitler 1997: 310–11; Kolb 2007: 146–153; Parr 2007: 281–83; see also Graf *et al.* 2005). As a consequence, some scholars have drawn attention to the apparent discrepancy between Strabo's account of the costly houses in Petra and the archaeological evidence (e.g., Parr 2007: 293). Wenning (2007: 36) has suggested that Strabo's description of Petra should be taken as portraying the situation in the late 1st century BC (see also Schmid 2001: 390–91; Tholbecq 2009: 48–50, 68).[9] On the other hand, as in the accounts provided by Diodorus, many misconceptions and outright errors have been pointed out in Strabo's description of Nabataean culture (e.g., Graf 1997a: 266–68), such as the puzzling account of the Nabataean treatment of the dead (Strabo 16.4.26; see Wright 1969 on a possible explanation). Some of these, like the supposedly "democratic" character of the Nabataean monarchs, may simply stem from the inability of a person from the Hellenistic/Roman cultural sphere to understand the tribal elements in the Nabataean culture, which their society plausibly also retained after sedentarization (for further references, see the discussion in Wenning 2007: 34–36; cf. Tholbecq 2009).

[9] Tholbecq (2009) dates Athenodorus' visit more precisely to 30 BC. However, see also Graf (2009) for an opposing view; Graf suggests that Athenodorus visited Petra during Pompey's eastern campaign between 67-62 BC.

A period of considerable building activity apparently took place in Petra in the final decades BC–early part of the 1st century AD (Schmid 2001: 374–90; Parr 2007: 286–93), largely contemporary with the reign of Obodas II (30–9 BC) and Aretas IV (9 BC–AD 40). Many of the monumental Nabataean tombs were constructed during this period (McKenzie 2005: 120–22). Based on the dating of the principal monuments, such as Qasr al-Bint (McKenzie 2005: 121; however, cf. Zayadine and Farajat 1991: 292–93), the Temple of Winged Lions (Hammond 1986: 29) and the "Great Temple" (Joukowsky 2004: 160–61, 2009: 294), this period also witnessed the monumentalization of the city centre and produced the layout of the city much as it is known today. Likewise, the first phases of the Nabataean private houses or "villas" excavated in ez-Zantur (Stucky 1996; Kolb 2007: 163–69) also date to this period, indicating the growth of the urban settlement in Petra.

3.2 The Roman period

The kingdom of Nabataea was annexed by Rome in AD 106, possibly following the death of King Rabbel II. There is no agreement among scholars concerning the reasons for the annexation, or, indeed, whether it was planned in advance or rather a reaction to the contemporary situation.[10] The new *Provincia Arabia* is for the first time attested on the milestones along the *Via Nova Traiana* between AD 111–114 (Graf 1995: 241; Freeman 1996: 113–14; Fiema 2003: 45). The only contemporary historian whose account of the annexation has been preserved is Cassius Dio, and even his account has only been preserved in an abridged Byzantine form (Hackl *et al.* 2003: 424, 429):

> *About this same time, Palma, the governor of Syria, subdued the part of Arabia around Petra and made it subject to the Romans.* (Cassius Dio 68.14.11-14)

Another account of the annexation can be found in the *Res Gestae* of the 4th-century historian Ammianus Marcellinus:

> *Adjacent to this region is Arabia, which on one side adjoins the country of the Nabataei [...] It was given the name of a province, assigned a governor, and compelled to obey our laws by the emperor Trajan, who, by frequent victories crushed the arrogance of its inhabitants when he was waging glorious war with Media and the Parthians.* (Amm. 14.8.13)

The traditional view has been that the annexation took place peacefully, without military conflict, but it has been disputed, and at least some level of resistance has been suggested (e.g., Bowersock 1996: 79–82; Schmid 1997; Joukowsky 2003: 396–97). It is mainly the above accounts of Cassius Dio and Ammianus, together with three Safaitic memorial inscriptions (Dussaud and Macler 1903: 122–123, No. 251; Winnett

[10] See Fiema (2003: 43–44 with bibliography), and Freeman (1996), for discussion of different theories and evidence about the annexation.

and Harding 1978: 406, No. 2815; Al-Khraysheh 1995: 410–13, No. 6; Hackl *et al.* 2003: 154–56, 158–59, 164–65) referring to a revolt against the Romans, that have given rise to the view that the annexation of Nabataea did not take place as smoothly as has been traditionally maintained (Hackl *et al.* 2003: 417, 429). The disappearance of mentions of Nabataea in the Roman literary sources after the annexation led to the suggestion that it may even have been some kind of an unofficial *damnatio memoriae* of Nabataea due to political reasons (Bowersock 1988: 51–52).

A limited but all the more interesting source for the period immediately before and after the annexation is formed by the documents of the Babatha archive (Papyri Yadin). The documents were found together, carefully packed in a leather purse, in a cave (the Cave of Letters) near the Dead Sea. They date from AD 94–132, that is, from the last decade of Nabataean rule to the first decades after the Roman annexation. The majority of the 35 documents are written in Greek and date to the period of Roman rule, but the archive also contains six documents in Nabataean (P. Yadin 1–4, 6, 9), which date to the period of the rule of Rabbel II (AD 70/71–106), the last Nabataean king. All the documents belonged to Babatha, daughter of Simeon, and they deal with transfers of property and legal matters (Yadin 1962: 235–47). For the present work, the archive is particularly interesting because it gives information on legal practices, agriculture and landownership in the Nabataean realm both before and after the Roman annexation. The last legal documents before the annexation date to AD 97/98 (P. Yadin 2, 3; Yadin *et al.* 2002: 201–44) and the earliest document after the annexation, which is also the earliest one in Greek, to AD 110 (P. Yadin 5; Lewis *et al.*1989: 29; 35–40).

In earlier scholarship, it was maintained that the relocation of the Nabataean capital to Bostra, changes in international trade routes, and the loss of political importance diminished the importance of Petra as a commercial centre soon after the Roman annexation (see the views summarized and criticized by Fiema 2003: 39–43). However, the archaeological research over the last three decades has confirmed that Petra maintained its status as a prominent urban and economic centre under Roman rule. The earliest evidence is the important inscription commemorating the bestowing of the status of *metropolis* to Petra under Trajan in AD 114 (Tracy 1999a; Bowersock 1983: 84–85). Although the Roman period in Petra has only recently begun to receive more archaeological attention, there is evidence of a number of changes instigated by the Romans in the monumental centre of Petra (Parr 1960: 129-130, 135; Fiema 2003: 48; Joukowsky 2004: 161, 2009: 294; Parr 2007: 293–95). The provincial governor was apparently not permanently resident in Petra, but Petra hosted periodic governor's assizes, as attested in the legal documents of the Babatha archive, which also hold the earliest known record of a *boule* in Petra in AD 124 (P. Yadin 12; Lewis *et al.* 1989: 29; 47–50).

The further honorific titles and status bestowed on Petra – *Hadriana Petra metropolis* under the reign of Hadrian, *colonia* under Marcus Aurelius Antoninus Elagabal[11] and *metrocolonia* first attested in a 3rd-century inscription (Starcky and Bennett 1968: 60, XIII; see also Fiema 2002a: 214–15) – indicate its continued prominence and prosper-

[11] Both honorifics are attested on the city's coins (Fiema 2002a: 214). *Hadriana Petra* occurs in P.Yadin 25.11 (see Comm.), dated to AD 131 (Lewis *et al.* 1989: 29; 108–112).

ity as a major city of the *Provincia Arabia* through the 2nd and 3rd centuries AD. A number of Latin and Greek inscriptions from Qasr al-Bint attest the presence of military and administrative personnel in Petra in the 2nd and 3rd centuries (Starcky and Bennett 1968: 51–57, VIII, IX, 59–60, XII). A city magistrate *(strategos)* is also known from a 3rd-century inscription (Starcky and Bennett 1968: 60–62, XIII).

Earlier research also assumed the rapid disappearance of the Nabataean cultural identity either through acculturation or population migrations after the annexation (see the summary of views, e.g., in Politis 2007: 187). While it is true that the cultural indicators considered Nabataean largely disappear from the northern parts of the former Nabataean realm relatively soon after the annexation, at present there is a considerable body of evidence for the continuity of Nabataean cultural traditions in what could be considered the heartland of the Nabataeans, that is, Petra, the Negev and Mada'in Saleh (Hegra) in Saudi Arabia, such as the continuity of certain Nabataean religious practices, the use of Nabataean prosoponyms (see, e.g., Frösén 2004: 142–43; Graf 2007b: 183–86; Politis 2007) and the continuity of ceramic traditions ('Amr 2004), into the Byzantine period.

The 3rd century witnessed a deep political and economic crisis in the Roman Empire. The decline of long-distance trade and decreased demand for luxury products are reflected in the production of unguentaria in Petra, which seems to end after the first quarter of the 3rd century (Johnson 1987: 53–54). The Petra–Gaza road also seems to have lost its importance (Cohen 1982: 240–47). The last dated imperial inscription from Petra is a fragmentary Latin honorific to Diocletian from ca. AD 283 (Sartre 1993: 69–70, text 41; Tracy 1999b). Although trade recovered to a certain degree afterwards, it seems that the 3rd century crisis caused a shift in exchange routes, which adversely affected the economy of Petra (Fiema 2003: 50; see also Erickson-Gini 2010: 72–73). This economic downturn is possibly reflected in the contraction of the area of urban settlement in Petra, which is visible from the 4th century onwards.

3.3 The Byzantine and Early Islamic periods

After the provincial rearrangements in the late 3rd–4th centuries (Sipilä 2004; 2009), Petra is known in literary sources as the capital of *Palaestina Salutaris*. The name *Salutaris* appears to be limited to the late 4th-century documents (*Not.Dign.*, Or. II.9, 14, 16, 17), and was supplemented by the early 5th century by *Palaestina Tertia* (*Cod. Theod.*: VII.4.30; Fiema 2002a:192). Petra is mentioned several times in Eusebius' *Onomasticon* from the early 4th century, first as *"Rekem (Ζαρκέμ). According to Josephus this is Petra, the famous polis of Palestina"* (Euseb., *Onom.* 36.13) and later as *"Petra (Πέτρα). A polis in the land of Edom in Arabia."* (Euseb., *Onom.* 142.7), and once more as *"Rekem (Ρηκέμ). This is the polis Petra in Arabia..."* (Euseb., *Onom.* 144.7).

A number of ancient sources record an earthquake on the 19th of May, 363, which affected several cities, including Petra. The most accurate of these is considered to be a letter from the late 4th or early 5th century attributed to Cyril of Jerusalem (Russell

1985: 42).[12] According to this source, *"more than half of Petra (RQM)"* was destroyed (Harvard Syriac 99, fol. 188b–190a: 11; transl. by Brock 1977). Destruction caused by this earthquake has been reliably attested in the excavations of the Late Roman houses of ez-Zantur I–II and IV. Habitation continued in ez-Zantur I and II, although on a reduced scale, but ez-Zantur IV was completely abandoned after the earthquake (Kolb 1996: 51; Kolb 2007: 157, 167). It seems that many of the monumental buildings in the city centre were severely damaged and left to lie in ruins or were only partially repaired (Hammond 1986: 26-29; Joukowsky 2004: 161–62, 2009: 294; Fiema 2002a: 198). Evidence of probable earthquake damage during this period has also been found in the excavation of the shops along the Colonnaded Street (Fiema 2002a:198-99). After the earthquake there is also evidence of the subdivision of houses (Kolb 1996) and the insertion of secondary structures into former public buildings and over previously open urban spaces (Joukowsky 2004: 161–62; Fiema 2002a: 198–99). In the light of the data from different excavations, it seems that by the mid-5th century large parts of the city of Petra within the walls were no longer occupied but were abandoned or in ruins. Habitation apparently continued in the Katute area in the southwestern part of the city, in the Colonnaded Street area, and on the north side of Wadi Musa (Fiema 2002a: 197, 221–22; Parr 2007: 297–98).

The urban status of Petra in the 4th century should be attributed to several factors. As a result of the decline of long-distance trade in the empire-wide economic turmoil of the 3rd century, Petra lost the revenue from the international trade. The administrative reforms in the 3rd–4th centuries also considerably reduced the economic independence of cities and led to a decrease in funds available for the civic authorities, while at the same time, the elite euergetism also declined (Fiema 2006: 73). Furthermore, it seems that by the late 4th century, Petra had lost its position in interregional commerce as well. This theory is supported by the archaeological finds since imports become rare in Petra after the 4th century (Fiema 2006: 75). This development is also reflected in the Negev, where imports from Petra cease to appear in the archaeological contexts after the later 4th century, to be replaced by imports from the north and the coast instead (Erickson-Gini 2010: 191–94).

Byzantine Petra was a religious centre within the region. Bishops of Petra are attested in the lists of some church councils starting with the Council of Serdica in 343. Until the Council of Chalcedon in 451, Petra was subject to the Patriarchate of Antioch and the metropolitan see of Bostra, but after the establishment of the Patriarchate of Jerusalem, Petra became a metropolitan see (Fiema 2002a: 193; Schick 2001: 1–2). In addition to the Urn Tomb, which was converted into a church under Bishop Jason in 446 (Brünnow and Domazewski 1909: 345), there are three Byzantine churches recently excavated in Petra (Fiema *et al.* 2001; Bikai 1996), constructed in the mid-5th to early 6th centuries (Fiema 2001: 55). A hermitage probably existed at ad-Deir (Schick 2001: 3), and the excavation at Jabal Harun, ca. 4 km to the southwest of Petra, has revealed a Byzantine monastic complex, which was established in the later part of the 5th century (Fiema 2008a: 94). According to the Jewish, Christian and Muslim traditions,

[12] Brock (1977: 281–83) has argued that the letter was not, in fact, written by Cyril, but by an anonymous contemporary, at the beginning of the 5th century.

Jabal Harun is the location of the grave of the prophet Aaron, Moses' brother (Frösén *et al.* 1998: 483), and the existence of a memorial church adjacent to the monastic complex on the mountain makes it probable that pilgrims came to Petra to visit the site (Fiema 2004: 130; see also Schick 2001: 2). Eusebius mentions "*Hor*" – presumably Jabal Harun – as *"The mountain on which Aaron died near the polis of Petra."* (Euseb., *Onom.* 176.7). Interestingly enough, Eusebius does not mention any Christian churches or sacred sites (in Petra or elsewhere) in *Onomasticon* (Notley and Zafrai 2005: xiii), although elsewhere he states that churches were already built in Petra during the 4th century (Euseb., *Comm. in Isaiam* II:23.42.12–15). This has led to the suggestion that Eusebius based the *Onomasticon* on earlier sources, possibly from the late 3rd century (Notley and Zafrai 2005: xv).

Although Christianity seems to have gained a footing in Petra relatively early, more than one church historian gives colourful descriptions of the pagan ways of the Petraeans in the 4th and even 5th centuries. In the late 4th century, Epiphanius (55.22.11) provides a description of pagan rites for Dushara and a virgin goddess "Chaamu," performed in Alexandria, in Elusa in the Negev and in Petra, which is *"the capital of Arabia, which is called Edom in the scriptures"* on the night of Epiphany. The rites described by Epiphanius testify to the continuity of the Nabataean religious traditions into the 4th century. Likewise, Sozomen (7.15.11) remarks that pagans in Petra *"contended zealously for their temples"*. Even as late as in the early 5th century, an apocryphal story relates that when the monk Barsauma went to Petra with his followers to destroy the pagan temples, the city gates were closed against him. Only after a miraculous rain fell on the city, which had been suffering from a three-year drought, causing a flood to wash away part of the town wall, did the pagan priests see the error of their ways and convert to the Christian faith (Schick 2001: 1).

After the 5th century, the literary sources about Petra become scarce, which was one of the reasons for the earlier understanding that the city was abandoned in the 6th century. Petra is missing from the major part of the Beersheva Edict, which lists the major communities in southern Jordan from 'Aqaba/Ayla to the Karak region (see Mayerson 1986). However, as pointed out by Fiema (2002a: 193), the absence of Petra may simply indicate that the city was not garrisoned at the time. Petra is included in Late Byzantine geographical listings. In Hierocles' *Synecdemus* (721.1–3) from ca. 527/528 (Honigmann 1939: 1–2), *Πέτρα* is mentioned as the first city in *Palaestina Tertia*, followed by Augustopolis (Udhruh). Both Petra, as *Πέτρα μητκόπολις*, and Augustopolis/Udhruh can also be found in the early 7th century *Descriptio Orbis Romani* by George of Cyprus (*Georg. Cypr.* 1043–1045), considered to reliably reflect the situation at the end of the 6th century (Schick 1994: 143).

It is also known that some exiled ecclesiastical leaders, as well as common criminals, were banished to Petra in the early 6th century (John Moschus, transl. Wortley 1992: 25; Joh. Malalas, transl. Thurn and Meier 2009: 410, 414) – *"either because the city was so insignificant and remote from Constantinople that they were considered harmless while in Petra, or because the city was considered safe and loyal"* (Fiema 2002a: 193). There are no ecclesiastical lists or church council records from the Late Byzantine period. Only a couple of bishops are known from Petra: Theodorus, who attended the anti-Monophysite Synod in

Jerusalem in 536 (*Acta Conc. Oec.* IV:3,2: 462, IV,3, 3: 250), and Athenogenes, a relative of Emperor Maurice, who was the bishop in the late 6th or early 7th century (John Moschus, transl. Wortley 1992: 103-107; Honigmann 1953: 223–25).

Considering the general paucity of ancient sources related to Petra from the Late Byzantine period, the Petra Papyri are all the more important. The papyri were found in 1993 in the course of the excavation of the Petra church in a small room adjacent to the church itself. A fire that had destroyed the church had charred and thus preserved the papyri. Altogether there were 152 rolls of papyri (Frösén 2001: 488). The texts are written in Greek and the preserved dates show that the archive covers at least the period from 537 to 593, although there may also be older scrolls for which the date has not been preserved (Frösén 2004: 141). The documents in the archive belong to one extended, wealthy family (see Lehtinen 2002), and they deal mostly with matters concerning taxation, inheritance and the sale of landed property. The papyri have been studied by two teams; one at the University of Helsinki, directed by Jaakko Frösén, and the other at the University of Michigan, directed by Ludwig Koenen. The reconstructed original texts and translations with commentaries have been published for 48 texts so far (Frösén *et al.* 2002; Arjava *et al.* 2007; Arjava *et al.* 2011). Especially as compared to the paucity of references to Petra in the Late Byzantine sources, the Petra Papyri have provided a wealth of new information. However, the view that the papyri give of the Byzantine-period reality of Petraean society is no doubt very selective. The writers and owners of the archive were certainly privileged individuals in the city, and there are many aspects of the society that the documents mention only in passing or do not cover at all. Valuable as the Petra Papyri are as a source, caution should be exercised when making generalizations based on the information in these documents.

The provincial administration of Petra after the 4th century is poorly known, although the town continued to be the capital of *Palaestina Tertia*. From the information in the Petra Papyri, it can be concluded that despite the increasing regionalization in the Byzantine period, Petra still held a preeminent position over Udhruh/Augustopolis and Sadaqa/Kastron Zadakathon in the 6th century. The titles of *metropolis* and *metrocolonia* were still in use, although it has been postulated that this may signify their importance for the local elite rather than reflect the reality (Koenen 1996: 178–83; 186–87). There is no evidence in the limited literary sources for the presence of a provincial administration in Petra during the Byzantine period, and no information about the governors is available after the 4th century. Nor is the relationship between the provincial administration of Petra and the imperial administration known (Fiema 2002a: 213–14). There is some evidence in the Petra Papyri, however, that the division of fiscal administration between the city and the imperial house may have been operative even as late as the middle of the 6th century (Koenen 1996: 186–87; Kaimio and Koenen 1997: 459).

The early 7th century was disrupted by the Sasanid invasion of Syria and Palestine in 613–14, which resulted in occupation for more than a decade. However, the impact of the Sasanian occupation (614–28) on the regions east of the Jordan river is poorly known. After the Sasanids were defeated, Byzantium officially regained control of the area for a period of a couple of years before the Islamic conquest of southern Jordan in 630 (Schick 1994: 146–48). The conquest did not apparently have any immediate im-

pact in the Petra region. Petra is not included in the Muslim lists of conquered towns, nor does it appear in the later Islamic sources. The archaeological evidence from Petra that can be related to Early Islamic habitation is sparse (Fiema 2001: 94–115; see also the review in Fiema 2002a: 198–200), although in the nearby villages, located at Khirbat an-Nawafla and in the modern Wadi Musa, settlement continues through the early Islamic period ('Amr *et al.* 2000: 241–44; 'Amr and al-Momani 2001: 267–68). A Greek dedicatory inscription from 687 (Zayadine 1971: 74–76, No. 2), found at ar-Rabba, points to the transfer of the metropolitan see from Petra to ar-Rabba after the Muslim conquest. The Islamic sources indicate that after the Muslim conquest, Udhruh took preeminence in the region, apparently supplanting Petra as its capital (Schick 1994: 144; 1997: 75).

CHAPTER 4 – PAST AND PRESENT EXPLORATION IN THE HINTERLAND OF PETRA

Until relatively recently, the knowledge of archaeological sites in the hinterland of Petra was largely based on the early surveys by Rudolf Brünnow and Alfred von Domaszewski (1904; 1909) and Alois Musil (1907) in the late 19th century, and Glueck in the 1930s (Glueck 1939; 1945). Although an increasing number of archaeological surveys were carried out, particularly from the 1980s onwards, these tended to be sporadic and site-oriented and concentrated on a few periods only. A further problem has been that the results of these surveys have not been published except in a very preliminary format. Only since the 1990s, have more systematic surveys been carried out in the Petra region, but still the survey methodology has mainly been extensive and off-site distributions of artefacts have not generally been documented. The results of these surveys also mostly still await final publication. Nevertheless, these surveys have contributed to the formation of a substantial body of data on the rural settlement in the area surrounding Petra.

4.1 Early archaeological surveys

The ambitious aim of Rudolf Brünnow and Alfred von Domaszewski (1904: VII–IX) was to produce a comprehensive description of both the geography and the archaeology of Transjordan. They made two journeys in Transjordan in 1897–98, travelling the whole length of present-day Jordan from Madaba to Aqaba in the south and from Ma'an along the edge of the eastern desert to as far north as Zarqa, from where they continued to Ajlun and on to Bosra. Brünnow and von Domaszewski mapped and documented many archaeological sites for the first time, and also added to the detail of previous documentation. They explored the Petra region, particularly the immediate surroundings of the ancient city, but they also covered the areas of Bayda and Udhruh, as well as the route from Udhruh to Sadaqa and from there to Ma'an.

Alois Musil (1907, 1908) made several journeys in both Palestine and Transjordan between 1896–98 and 1900–02. He was not an archaeologist or a historian himself, and the purpose of his travels was to carry out topographic measurements and map-

ping, but alongside this work, he documented several archaeological sites. During his journey in 1896, he visited Petra and made a detailed documentation of archaeological sites within the city and in its surroundings. The sites documented by Musil are mostly Nabataean graves and cultic installations, but they also include the ruins of the Crusader keep on al-Wu'eira and the shrine on Jabal Harun. Musil also visited Udhruh and travelled as far east as Ma'an, which he visited more than once, but he did not document archaeological sites in their vicinities.

Gustaf Dalman (1908, 1912) likewise carried out archaeological research in Petra in the early 20th century. His research concentrated particularly on the Nabataean high places and other cultic sites in and around the city of Petra. He made careful documentation of the cultic installations and niches, and also documented a large number of Nabataean and Greek inscriptions. However, he paid little attention to other sites, such as building remains.

Another German, Theodor Wiegand, visited Petra and its surroundings during the First World War as a member of the Deutsch-Türkisch Denkmalschutz-Kommando project (Wiegand 1920, 1921), which documented many archaeological sites in the then Ottoman Empire. However, in Petra the group was only interested in the tombs and the remains of monumental buildings. The only site that they documented outside the city centre consisted of the remains on top of Jabal Harun, and even there they ignored the ruins of the monastic complex on the plateau below (Wiegand 1920: 136–45).

Nelson Glueck (1939, 1945) conducted extensive explorations in Transjordan in the 1930s. Glueck also visited and documented many sites in the Petra region, recording many of them for the first time. As befits his interests as a Biblical archaeologist, he attempted to establish a connection between the major archaeological sites and Biblical places. He categorized most of the sites in southern Jordan as Edomite, Nabataean or Roman, and often attached a military function to them. Although the value of Glueck's achievement should not be dismissed, the development of pottery typology since his times, has shown that many of the sites first visited by Glueck have longer settlement histories than originally suspected by Glueck, and their functions may also be different from Glueck's original interpretations (e.g., Graf 2001a: 476; 1979).

4.2 Archaeological surveys in the last thirty years

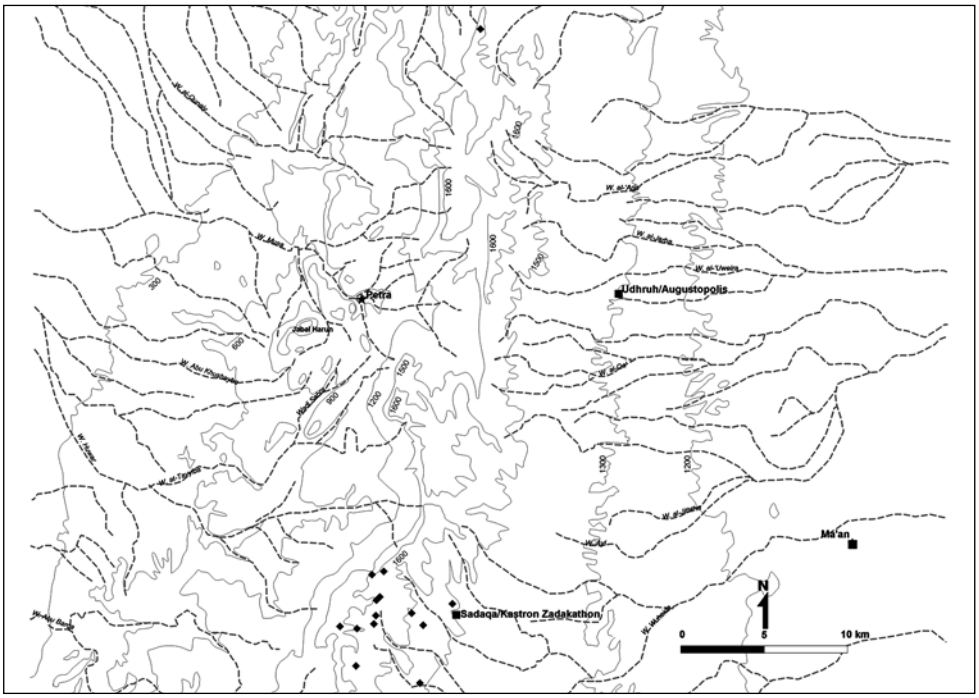
After these early explorations, archaeological research in the Petra region largely concentrated on excavations in the city itself, and particularly on its monumental public buildings. Since the 1970s, localized surveys and a number of small-scale excavations outside the city centre by Manfred Lindner and his team from Die Naturhistorische Gesellschaft Nürnberg made a significant contribution to the archaeology of the hinterland of Petra especially regarding the Bronze and Iron Ages and the Nabataean–Roman period, but also including Early and Middle Islamic sites (e.g., Lindner 1987; Lindner *et al.* 1996a, 1996b; Lindner *et al.* 2000).

A number of archaeological surveys were carried out in the Petra region in the 1980s. Mostly these surveys concentrated on certain periods and questions. Stephen

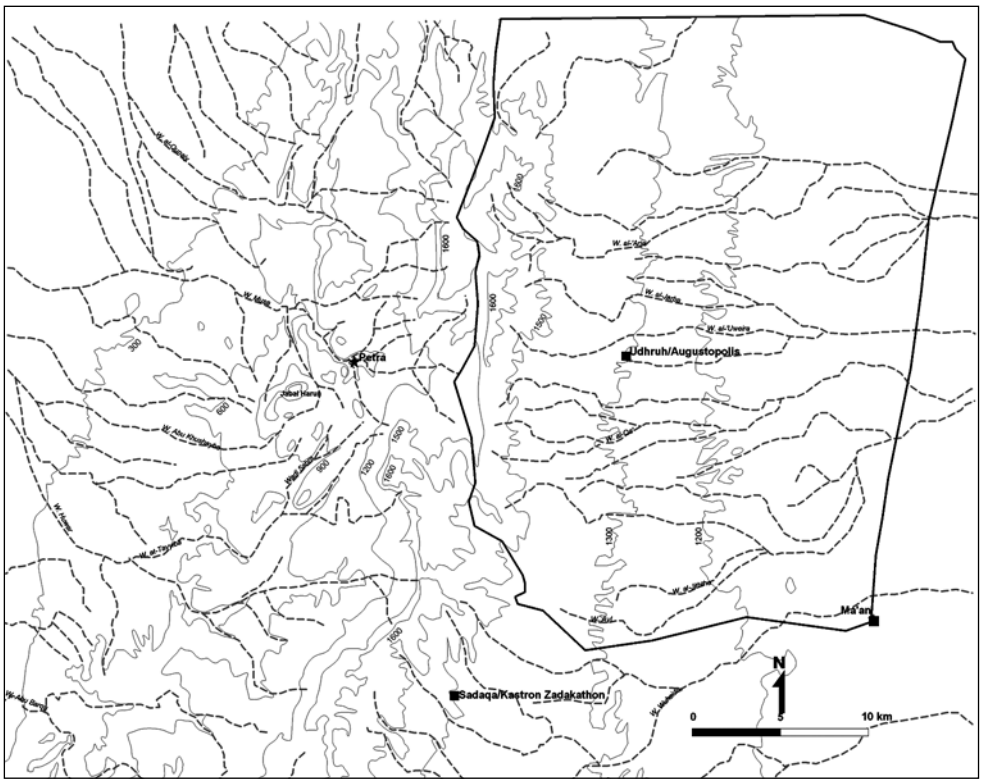
Hart (Hart and Falkner 1985; Hart 1986) conducted a survey between Tafila and Ras an-Naqb, bounded by the escarpment and the desert in the east. This survey included a more detailed survey in an area extending from Ras an-Naqb in the south roughly to Sadaqa in the north, and visits to a number of sites between northern Jabal ash-Shara and Tafila. The area considered here as the hinterland of Petra was therefore not included in the survey for the most part (Map 3). The survey concentrated on ceramic material only, effectively limiting it to periods from the Iron Age onwards. Nabataean-Early Roman material, dated mainly to the 1st century AD, was predominant at the surveyed sites, and only a few sites with Late Roman-Byzantine material were found (Hart and Falkner 1985: 255–56).

A. Killick (1982; 1983; 1986; 1987) conducted a survey in the surroundings of Udhruh (Map 4), concentrating on the Roman to Byzantine periods, and an excavation at the fortress at Udhruh. Around 200 sites, most of them previously unknown, were reportedly recorded in the survey, among them extensive Byzantine settlements north and east of Udhruh (Killick 1986: 432), but unfortunately there is very little information about them available because the full results of the survey have not been published.

Starting in 1980, W.J. Jobling (1982; 1983; 1984; 1985) and his team spent several seasons carrying out the 'Aqaba – Ma'an survey, which concentrated on the marginal zones on the desert fringe. The survey work concentrated to the south of the region



Map 3. Sites recorded by the Edom survey in the hinterland of Petra (based on information in JADIS).



Map 4. The area of the Udhruh survey by A.C. Killick (after Killick 1987).

considered in this work. The archaeological materials collected by these surveys were mainly epigraphical and rock art, but a number of other archaeological sites were also recorded.

G.R.D. King *et al.* (1982; 1983; 1987; 1989) made a survey of Byzantine and Islamic sites in Jordan in the early 1980s. The aim of the survey was to reexamine the material remains related to the transition from the Byzantine to the Early Islamic period. The emphasis of the survey was in northern and central Jordan, but sites south of the Dead Sea, in southern Ghors (King *et al.* 1987) and in Wadi 'Araba (King *et al.* 1989), were also surveyed. The sites visited within the Petra region were Bir Madhkur, Qasr Wadi Musa and Qasr at-Tayyiba.

The Beidha Ethnoarchaeological Survey by E.B. Banning and Ilse Köhler-Rollefson (1983) was unusual in the sense that it was aimed at recognizing and understanding nomadic occupation in the archaeological record. The focus was on recent Bedouin camp sites, but also archaeological sites, mainly Nabataean ones, were recorded. The publications of the project have concentrated on the ethnoarchaeological material, and the information concerning the archaeological sites has been published only in a preliminary report (Banning and Köhler-Rollefson 1983).

David Graf (1979) surveyed a number of Nabataean-Roman military sites in the Hisma desert between Ras an-Naqb and 'Aqaba, and along Wadi Ram, in 1978. In

another project carried out in 1986–89 (1992, 1995) Graf surveyed mainly Nabataean to Byzantine sites in the Jabal ash-Shara area and on the eastern plateau in connection with the survey of the Roman road system between Petra and 'Aqaba. Because the aim was the documentation of roads, the sites visited are the ones in the immediate vicinity. Many of them have been identified as being related to the monitoring of the caravan traffic, but there are also a number of settlements. However, the sites visited in the survey were mostly previously known, and the documentation published concerning the sites is limited.

Burton MacDonald has conducted several regional survey projects in southern Jordan since the late 1970s, starting from Wadi al-Hasa (WHS; 1979–83; MacDonald 1988a) and southern Ghors (SGNAS; 1985–87; MacDonald 1992) and moving southward. He carried out a survey of the Tafila-Busayra region (TBAS) in 1999–2001 (MacDonald 2004 *et al.*), and most recently (starting in 2005) he surveyed the area between Ayl and Ras an-Naqb (ARNAS), covering also a part of the area considered here. The final publications for MacDonald's surveys are available except for the most recent one, the preliminary results of which have been published in the *Annual of the Department of Antiquities of Jordan* (MacDonald *et al.* 2005; 2006).

Since the 1990s, a number of survey projects have been carried out in southern Jordan. The Southeast Araba Archaeological Survey (SAAS), started by Andrew II Smith in 1993 (Smith *et al.* 1997), a regional study of the floor of Wadi 'Araba, extended from the immediate environs of 'Aqaba to Wadi Abu Barqa ca. 70 km north – northeast on the eastern side of the 'Araba highway. Although the actual survey area was south of the area considered here, the SAAS team also visited some of the major sites on the western periphery of the Petra region, namely Qasr Wadi at-Tayyiba and Bir Madhkur. The SAAS was later followed by the Bir Madhkur Project (BMP), which concentrates on this important fort and caravan station, and its environs, ca. 10 km northwest of Petra (Smith 2005). The BMP sites show that settlement was more widespread on the western periphery of Petra than previously known. More detailed data about the sites was published in 2010 (Smith 2010), but the dating used in the site descriptions is too broad and unspecified to include the sites in the analysis.

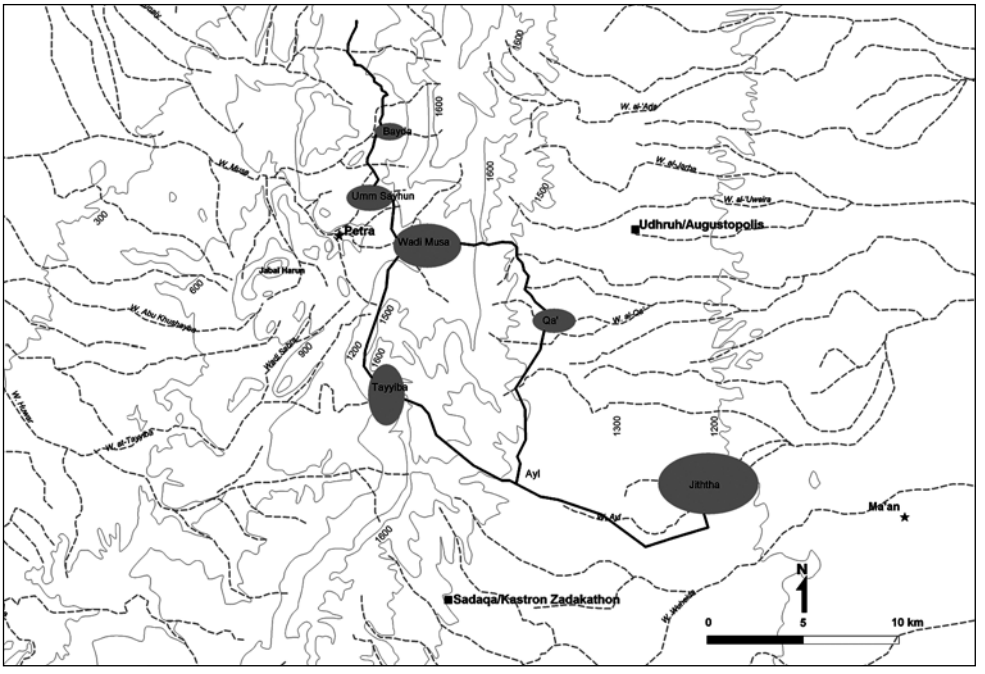
The Jabal Shara Survey (JSS), carried out by the French Institute of Archaeology in the Near East (IFAPO) in 1996–97, comprised the Wadi Musa drainage basin, concentrating on the time period from the Iron Age to the Late Islamic period (Tholbecq 2001: 399). The work was based on a preliminary investigation of aerial photographs, on which sites were identified. The total number of sites visited by the JSS is 160, including both previously known and newly identified sites. Nabataean remains were attested at the majority of the sites, 55%. The Early Byzantine period (4^{th}–5^{th} centuries) was represented at 10% of the sites, while Late Byzantine (6^{th}–7^{th} centuries) remains are present at less than 5% of the sites (Tholbecq 2001: 400–405). Unfortunately, no detailed information on the sites and their function is available.

The Dana Archaeological Survey (DAS; Findlater 2002) aimed at understanding the state resource control and organization in the Faynan, Dana and Shawbak areas from the Iron Age to the Byzantine period. The surveyed area extended from Busayrah in the north to Wadi al-Arja, north of Udhruh, in the south, thus covering a large part

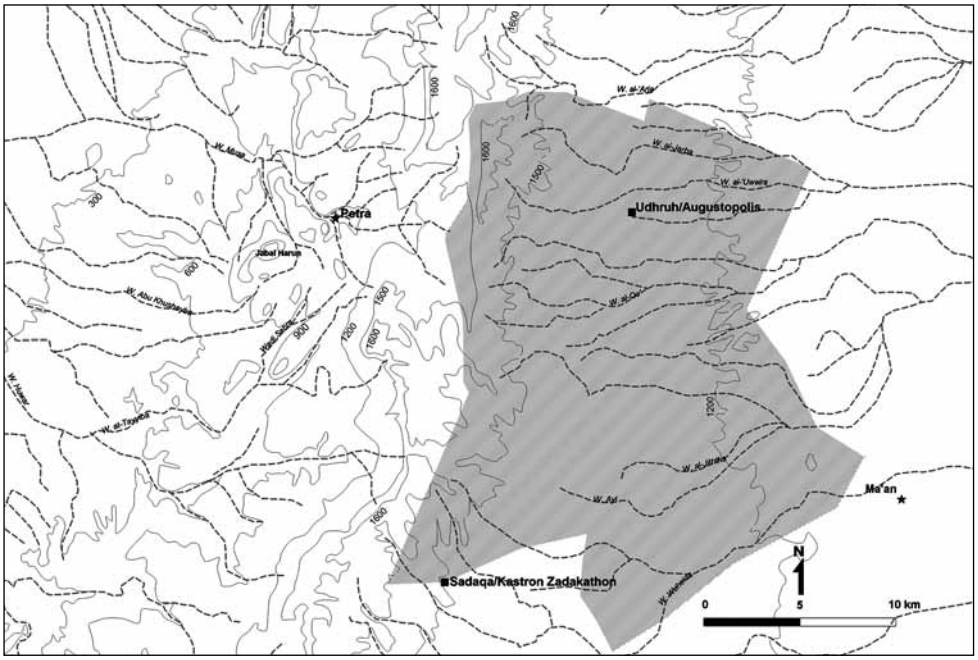
of the area of the earlier Edom survey (Hart and Falkner 1985). More than 400 sites were surveyed, but the results are so far unpublished. The archaeological remains at al-Hammam and east of it, to the north and northeast of Ma'an, were also surveyed as part of the Swiss-Liechtenstein Foundation's Umayyad Settlements project during a short season in 2002 (Genequand 2003).

An essential source of information for the research at hand is the Wadi Musa Water Supply and Wastewater Project Survey (WMS), carried out by the Department of Antiquities of Jordan in 1996 and 1998–2000 ('Amr *et al.* 1998; 'Amr and al-Momani 2001). The aim of the survey was the management and protection of antiquities in connection with planned large-scale water supply works in the region. Due to the focus of the survey, the area covered by the survey was limited to the immediate vicinity of the planned pipeline, which is ca. 60 km long (Map 5). No information on the actual area covered by the survey is available, and neither is any more precise description of the survey methodology. The results include both survey and excavation data, and the detail of information available on individual sites is variable. Despite the selective areal coverage, topographically and environmentally the survey covers diverse areas from the foothills of Jabal ash-Shara in the west to the desert fringe in the east ('Amr and al-Momani 2001: 253–54), thus providing a useful cross-section of the settlement in the hinterland of Petra.

The total number of sites recorded in the WMS is 132, most of which were newly discovered during the course of the project ('Amr and al-Momani 2001: 253–54, 283). Altogether ca. 52% of the settlement sites have Byzantine (4th–early 7th century) ma-



Map 5. The WMS area. The water pipelines are indicated by the black solid lines, the larger surveyed areas with grey (compiled after the maps in 'Amr and al-Momani 2001.)



Map 6. The area of the Udhruh region survey by Abudanh. (After Abudanh 2006.)

terial remains, compared to the total of 87.5% of the settlements having Nabataean-Roman (1st century BC–3rd century AD) material remains. Calculated on the basis of the information presented in 'Amr *et al.* (1998) and 'Amr and al-Momani (2001), of the total number of settlement sites visited in the survey, ca. 31% have Early Byzantine material remains while ca. 21% have Late Byzantine material remains. In addition, 12.5% of the sites have unspecified Byzantine remains.

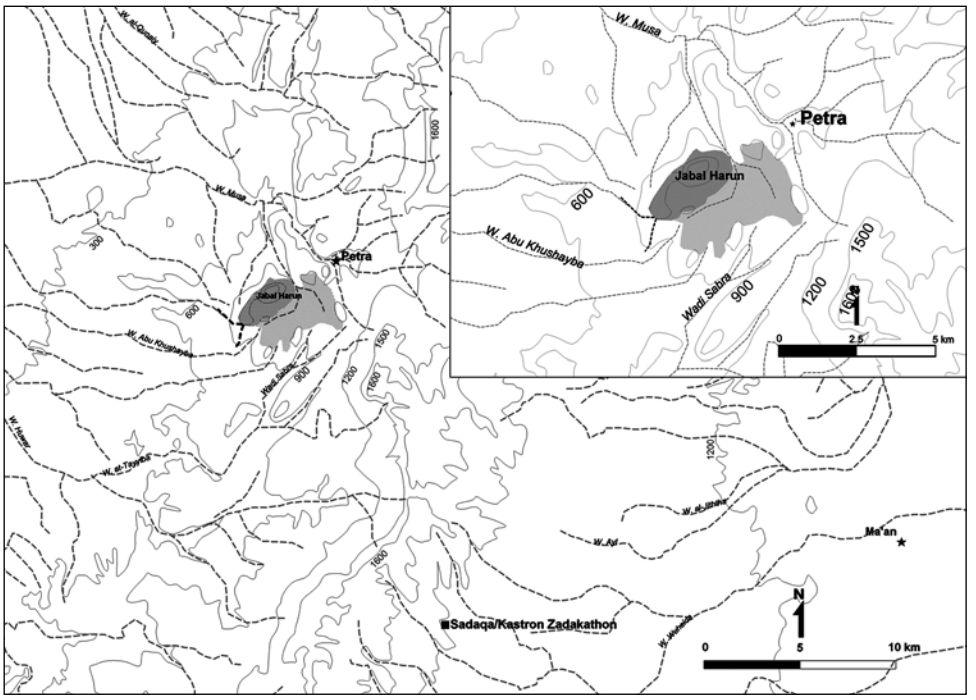
Another invaluable source for archaeological data for this work was the survey conducted by Fawzi Abudanh (2006) for his doctoral dissertation in 2003–2004. The survey covered an area of roughly 700 km^2 (Abudanh 2006: 39), between Wadi Musa in the west and Udhruh in the east, stretching from the Wadi Musa – Shawbak road in the north to Sadaqa in the south (Map 6). The area considerably overlaps the WMS and complements it in the Jabal ash-Shara area, besides providing important information about sites further east towards Udhruh and Ma'an. The survey was conducted as an extensive, site-oriented survey, which heavily relied on visibility in locating sites and included pedestrian survey only at site level (Abudanh 2006: 42–45). Thus, it is not surprising that very few prehistoric sites were mapped in the survey. However, for the periods under consideration, the material can be considered representative.

The FJHP survey

The Finnish Jabal Harun Project (hence the FJHP), directed by Professor Jaakko Frösén, was designed to study the spatial and temporal variations in human occupation in

the area of Jabal Harun through the ages, with a special emphasis on the Byzantine monastic site on the high plateau of the mountain (Fiema 2008b: 54). The FJHP consists of two interrelated parts: the excavation of the Byzantine monastery/pilgrimage centre on the top plateau of Jabal Harun, and an archaeological survey in the surroundings of the mountain. After a reconnaissance season in 1997 (Frösén *et al.* 1998), the full-scale excavation and survey started in 1998. The FJHP survey was designed to provide information about the settlement history and land use in the area surrounding Jabal Harun. The fieldwork took place over a period of five to eight weeks every year between 1998 and 2007 (Frösén *et al.* 1999; 2000; 2001b; 2002; 2003; 2004). In 2001, the survey team was not in the field and there was no field season at all in 2004. The final field season of the survey took place in 2005 (Lavento *et al.* 2007a). The survey is methodologically divided into an intensive, non-site survey in the immediate surroundings of the mountain, and an extensive, site-oriented survey in the areas towards Petra, Wadi Sabra and Wadi 'Araba (Map 7). In the intensively surveyed area, the sites and structures were mapped by total station, while in the extensive survey, the locations of the observed sites were recorded by handheld GPS.

In the main survey area, covering only ca. 4.8 km^2, the fieldwork was executed as a systematic intensive survey. Where topographically feasible, the area was divided into tracts, which covered 28.5 % of the entire intensive survey area. The average area of a tract was 0.6 hectares, although in practice their size and shape varied depending on the geomorphological constraints. The tracts were line-walked with a distance of ten



Map 7. The location of the FJHP survey area. The intensively surveyed area is indicated by the darker shading. The dotted lines indicate the survey of routes to Wadi 'Araba in 2005.

metres between walkers, and all artefacts found were collected and counted. Structures, groups of structures and concentrations of lithics or pottery sherds were defined as sites (Lavento *et al.* 2004: 225–27). Over six seasons of fieldwork, 246 tracts were walked and 189 archaeological sites were defined in the intensive survey area (Appendix II, Map 8).

The most common site category in the intensive survey area consists of hydraulic structures, namely barrage and terrace wall systems. Most of these sites were not previously recorded. Other common site types are lithic scatters and remains of building structures, which often also yielded pottery. Building remains include possible farmhouses, cultic installations and small structures, many of which appear to be related to an ancient caravan route which crosses the survey area (Frösén *et al.* 2000: 418; 2001a: 389–91; Zayadine 1985: 164). This route is probably one of the optional routes from Petra to Wadi 'Araba, continuing further through the Negev to Gaza (Cohen 1982; Ben-David 2007). Most of the building remains in the survey area have been dated to the Nabataean-Roman period on the basis of the pottery found in relation with the structures, but there are also a few structures which have no associated pottery, as well as concentrations of pottery with no associated structural remains, which have been interpreted as possible campsites. Other sites include rock-cut Nabataean graves and water channels. There are also numerous petroglyphs, especially on the slopes of Jabal Harun, many of them apparently related to pilgrimage to the mountain.

The extension of the survey area towards Petra and Wadi Sabra covered ca. 6.5 km^2, thus making the total surveyed area ca. 11.3 km^2. The aim of the extension in 2005 was to fit the Jabal Harun area into its wider environs and particularly to understand the relationship of the area with Petra. Covering a relatively large geographical area in a limited time required the adoption of different survey methods. The team was divided into three groups of two people moving on foot. One group concentrated on the ancient routes, while the other two groups covered the area from the borders of the intensive survey area up to Tulul Muthayliyya and Wadi al-Bitahi in the south and to the Snake Monument in the direction of Petra. No tracts were walked in the extensively surveyed area, and only samples of finds were collected at the recorded sites. Areas that were deemed topographically unlikely to yield archaeological sites based on our earlier experience were not surveyed. The group focusing on ancient routes crossing the Jabal Harun area followed two main routes, one leading from Petra towards Abu Khushayba in the southwest and another running towards the west and north, to Umm Ratam. (Lavento *et al.* 2007a: 289, 293–99.)

Altogether 171 sites, including both newly discovered and previously known ones, were recorded during the extensive survey work. The types of sites included petroglyphs, concentrations of flint material, several Nabataean cisterns – some of them reused by the Bedouin – and rock-carved water channels, Nabataean cultic installations, tombs and rock-cut graves as well as stone-lined grave pits dug in the earth, several remains of buildings from small one- or two-room structures to multi-room buildings with courtyards, and small, structureless stone heaps, many of them associated with Nabataean pottery and identified as possible graves. In addition to these sites, numerous terrace walls and wadi barrages were noted in the areas surveyed towards Wadi Sa-

bra and Petra. The total number of sites recorded by the FJHP survey is therefore 360, including both newly documented and previously known sites. The final publication of the survey results is currently underway, and some of the material is still being studied. Therefore, the pottery analyses for the tract pottery used in this work were still mainly preliminary, but for the sites discussed here, the final pottery analyses by Ms. Yvonne Gerber were already available.

CHAPTER 5 – ENVIRONMENTAL CONDITIONS

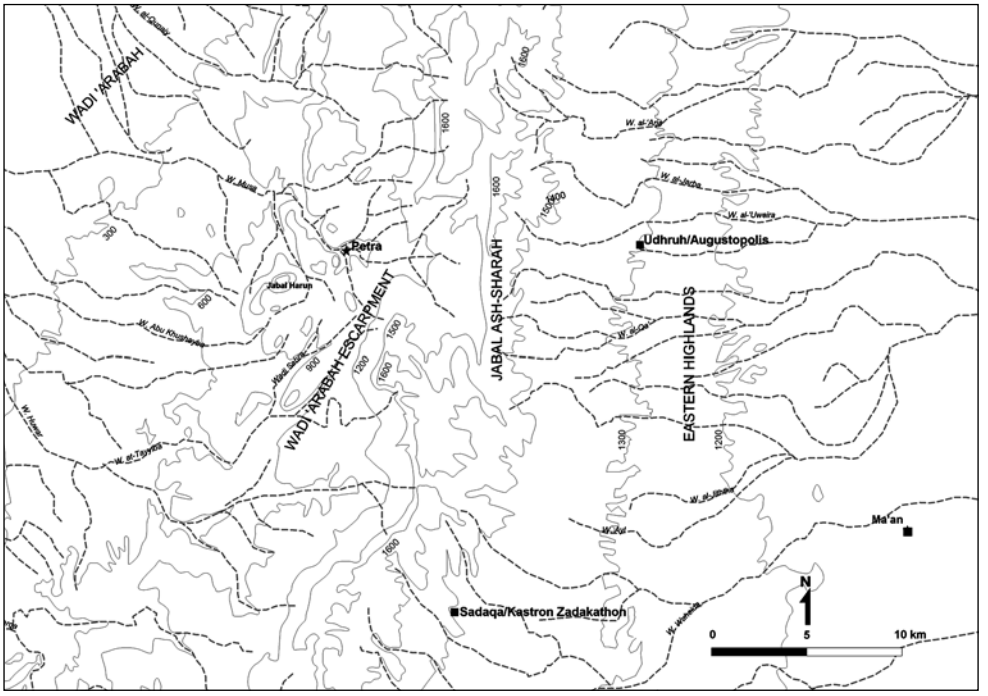
In most parts of the Petra region, the conditions for agriculture are marginal and cultivation is not possible without some form of irrigation. The limited availability of such resources as water and arable land can be expected to influence the location of settlement and the possible modes of subsistence and agriculture. Furthermore, there are significant differences in the environmental conditions within relatively short distances in the different parts of the Petra region, which suggests that some areas may have been preferred for sedentary settlement and agriculture. The marginal conditions also imply that the area is vulnerable to environmental change as a result of climatic change and human activity. This situation has led several researchers to postulate that environmental change may have played an important role in the settlement changes within the Petra region. Here, the basic environmental conditions will be outlined, together with a reconstruction of the climate history from the last glacial to the present, based on palaeoclimatic studies in the Levant. The question of the role of climatically driven environmental change in the rural settlement patterns during the period from Nabataean-Roman to Late Byzantine-Early Islamic times will be more closely considered in Chapter 8.

5.1 Present-day environmental conditions in the Petra region

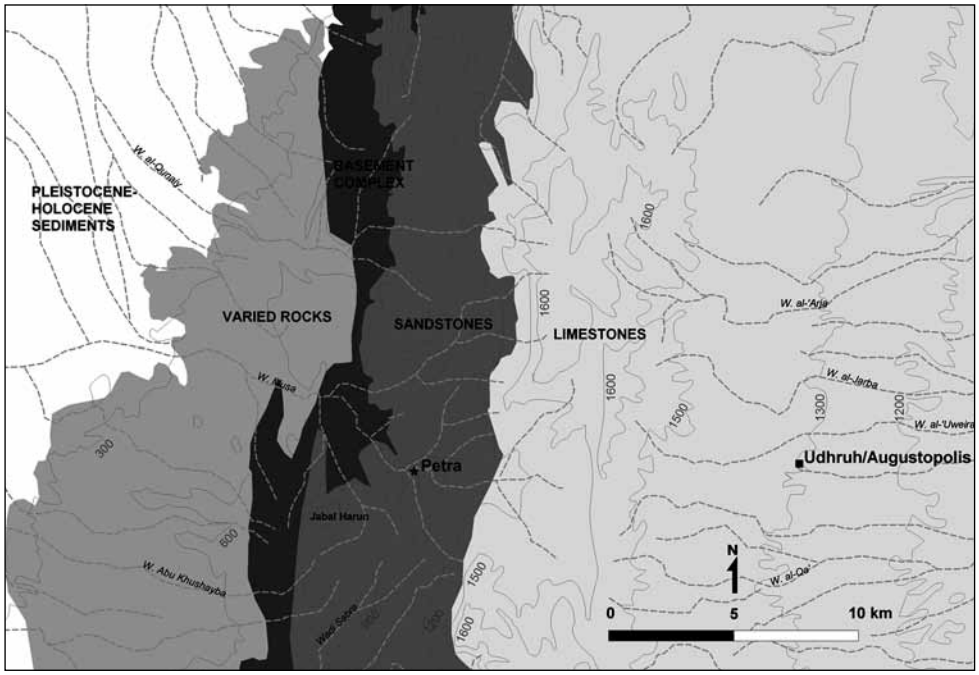
Petra is located in a valley ca. 800 m asl in the eastern part of the Wadi 'Araba Escarpment, between the highlands in the east and Wadi 'Araba in the west. Wadi 'Araba is part of the Jordan Rift Valley, which forms the northernmost part of the long fault system stretching about 6000 km from North Syria to East Africa. The formation of the rift, which began during the Miocene, was caused by the movement of the Arabian plate to the NNE relative to the Sinai microplate. Recurring phases of tectonic movement have resulted in a strike-slip movement of 107 km along the rift by the present day. In the surrounding areas, the formation of the rift has caused considerable vertical movement and extensive faulting of the bedrock (Abed 1985: 81–82). Tectonic movement has continued along the fault systems up to the present day, resulting in

earthquakes in the Petra area, some of which have also been documented in historical sources (Russell 1985).

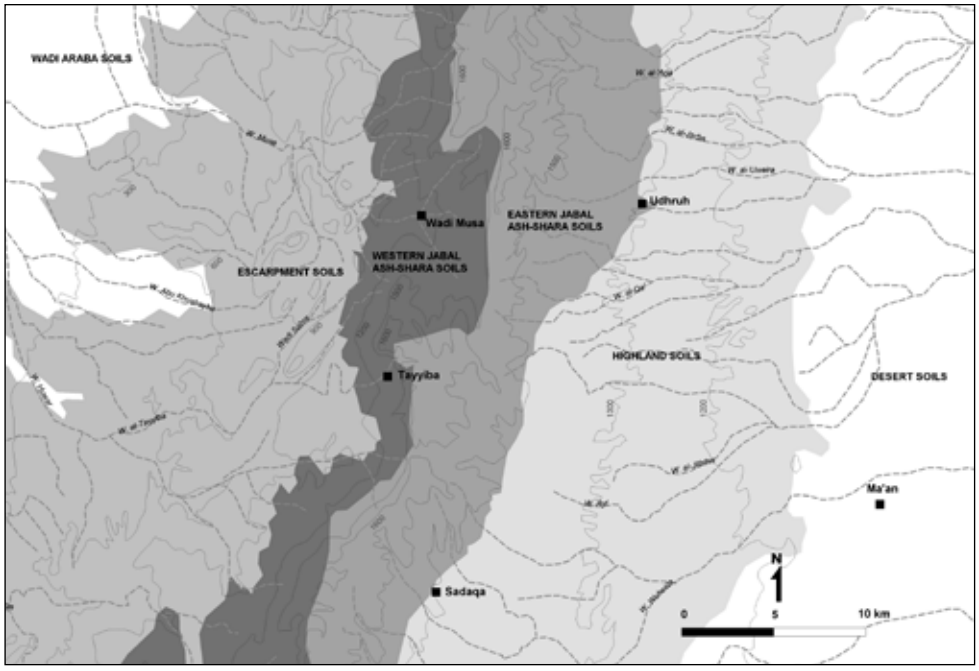
The highest elevations are in Jabal ash-Shara, which forms the main watershed of the region (Map 9). The Jabal ash-Shara area reaches 1300 m asl, with the highest peaks rising over 1700 m. The bedrock of the area is formed of Cretaceous limestones of the Balqa and Ajlun groups and the Early Cretaceous Kurnub Sandstone (Map 10). Only on the western edge of Jabal ash-Shara, are the underlying Cambrian and Ordovician sandstones of the Ram Sandstone group exposed (Natural Resources Authority 1995). The layers are tilted towards the west on the eastern part of the formation, and along the edge of Wadi 'Araba they are downfaulted towards the rift along the complicated fault systems (Bender 1974: 23). The existence of the impermeable sandstones under the porous limestones results in the occurrence of springs along the border between the limestones and sandstones on the western slopes of Jabal ash-Shara (Lane and Bousquet 1994: 31; Besancon 2010: 39). Likewise, the tectonic history of the area has resulted in a number of springs in the central and eastern parts of Jabal ash-Shara, where the water seeping into the calcareous bedrock surfaces in thalwegs. The relief of the central and eastern ash-Shara area mainly consists of elongated, N-S oriented rolling hills and uplands (Besancon 2010: 39–40). The soils (Map 11) are stony and sandy loams, which belong to the yellow Mediterranean soils (Bender 1974: 189; Royal Jordanian Geographic Centre 1995; Jordan Soils & Land Management 2006). The network of ephemeral channels is dense, and numerous wadis run both east and west of Jabal ash-Shara.



Map 9. Geographic areas in the Petra region.



Map 10. The major components of bedrock in the Petra region. Compiled after the 1:50,000 Petra/Wadi al-Lahyana Lithological Map (Natural Resources Authority 1995).



Map 11. Major soil regions in the Petra region. Based on the 1:250,000 Soil Map (Royal Geographic Centre 1995).

Jabal ash-Shara is separated from the Wadi 'Araba Escarpment in the west by steep, high slopes. The elevation drops rapidly from the maximum of more than 1700 m asl at the western edge of the ash-Shara range to the 800–1000 m of the escarpment, which is a strip of elevated land between ash-Shara and Wadi 'Araba (Map 9). The escarpment is only ca. 10 km wide in the Petra region. The bedrock of the escarpment consists mainly of Ordovician and Cambrian Ram Sandstones, although there are also exposures of Precambrian volcanic rocks and conglomerates, and pockets of Creataceous limestones in areas of tectonic subsidence (Map 10). Northwest of Petra, along the Al-Quwayra fault zone, there is an area of Basement Complex rocks, which form steep and almost impassable slopes towards Wadi 'Araba (Natural Resources Authority 1995). The topography of the escarpment is rugged and characterized by extensive faulting and heavy erosion caused by the tectonic movement in the Wadi 'Araba fault, which has created the sandstone massifs characteristic of the escarpment area (Fig. 1). The widest areas of relatively even ground are in the Petra Valley and north of it, in the surroundings of Bayda. The major channels, which are joined by numerous branching tributaries, run towards Wadi 'Araba in deep gorges, which often follow zones of tectonic weakness. Much of the area consists of bare bedrock or shallow, stony soils produced by in situ weathering of the bedrock (Royal Jordanian Geographic Centre 1995), although thick sandy deposits of great antiquity can be found on the banks of wadis.

From the western edge of the escarpment, there is another drop in elevation down to 100–200 m asl on the floor of Wadi 'Araba (Fig. 2). Thus, there is a drop of



Figure 1. An escarpment landscape seen from Jabal Harun and looking towards Wadi as-Sabra in the south. (Photo: P. Kouki.)

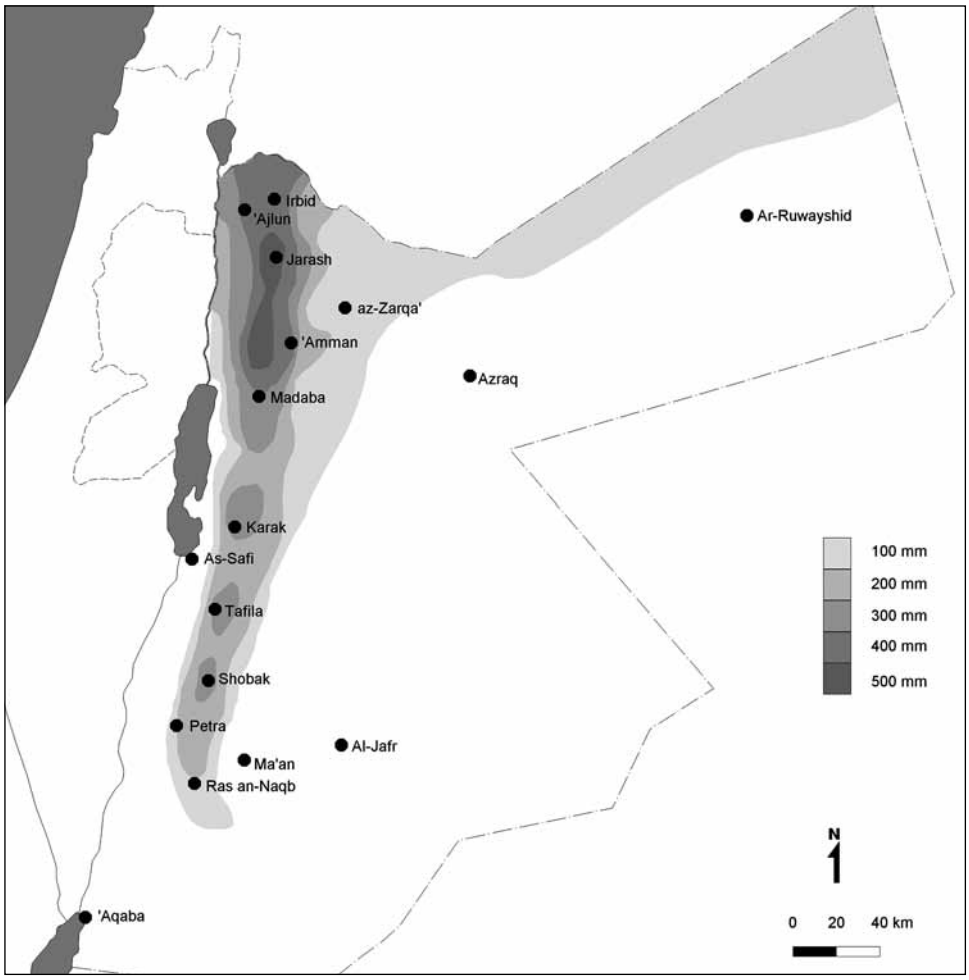


Figure 2. A view from Wadi 'Araba towards the east. The Wadi 'Araba escarpment in the background. (Photo: E. Hertell.)

more than 1500 m in elevation within a distance of no more than 15 km from Jabal ash-Shara to Wadi 'Araba (Map 9). Between the escarpment and the floor of Wadi 'Araba, the al-Quwayra and the Wadi 'Araba fault zones form an area of broken, hilly terrain. The bedrock lithology of this area is very variable, reflecting its complicated tectonic history (Map 10). The wadis running down from Jabal ash-Shara and the Escarpment discharge into Wadi 'Araba, forming shallow channels and wide fans. The soils are formed of Pleistocene–Holocene stream deposits and wadi fan sediments consisting of thick layers of sands and gravels (Map 11; Bender 1974: 25; Natural Resources Authority 1995), and they are highly calcareous and very saline (Royal Jordanian Geographic Centre 1995; Jordan Soils & Land Management 2006).

East of Jabal ash-Shara, there is no sudden change of elevation as in the west. The hills of the Jabal ash-Shara area gradually become undulating highlands intersected by wide valleys. In the pre-desert area, the landscape is more level, with isolated hills (Abudanh 2006: 5). The elevation drops eastwards to the Al-Jafr Basin, the periphery of which is ca. 1000 m asl (Jordan Soils & Land Management 2006). There are numerous large wadis running east from Jabal ash-Shara, which form floodplain environments on the eastern plateau. The bedrock is formed of Cretaceous and Lower Tertiary limestones and marls (Bender 1974: 8, 21–22, 100). Soils consist of alluvial sand and gravel deposits and in situ weathering products. Along the western edge of the highlands, in the area of higher mean annual rainfall, yellow steppe soils can be found (Map 11), while further to east these are replaced by desert soils and *hammada* (Bender 1974: 189–90).

Cyclones generated over the Mediterranean basin affect Jordan between October–November and April, resulting in rainfall during the winter months. In summer, the Azorian high pressure belt is strengthened and expanded, blocking the cyclones from the eastern Mediterranean and resulting in hot and dry weather, controlled by subtropical high pressure cells (Shehadeh 1985: 25). Rainfall in Jordan is controlled by physiogeography and latitude (Map 12). The decrease of the amount of mean annual rainfall from north to south is related to the increased distance from the main tracks of the Mediterranean depressions. Due to the physiogeography of the country – the highest elevations are found at the mountain range stretching along the eastern side of the Wadi 'Araba-Jordan Rift – rainfall also decreases to both the east and the west of the mountain range (Shehadeh 1985: 30–31). The southern parts of the country are, on the other hand, more influenced by local instability of weather conditions due to the extension of the Red Sea Trough, which may cause torrential rainfall and flash floods (Freiwan and Kadioglu 2008: 524–25).



Map 12. Distribution of rainfall in Jordan (after Shehadeh 1985: 31).

In the Petra region, rainfall is mostly generated when the moist airmasses are lifted over the Jabal ash-Shara range. As a result, rainfall is most abundant on the slopes of the mountains, where the mean annual precipitation is ca. 200 mm. From there, the mean annual precipitation drops sharply both towards the west and to the east, being ca. 180 mm in Wadi Musa and only ca. 50 mm on the floor of Wadi 'Araba, and even less than that in Ma'an on the desert margin (Meteorological Department of the Hashemite Kingdom of Jordan 2004). Most of the rainfall in the Petra region comes in the winter months, between January and February (Tarawneh and Kadioglu 2003: 132). The annual temporal and spatial variation of rainfall also increases with distance from the Shara range (see Freiwan and Kadioglu 2008: 525; cf. Kutiel *et al.* 2000: 278–80).

Variation in temperature is also considerable in the Petra area. The warmest month is August with a mean maximum temperature of 24.1°C, and the coldest is January with a mean minimum temperature of 8.0°C, although temperatures above thirty degrees and below zero, respectively, are not uncommon (Wadi Musa, period 1984–1998; Meteorological Department of the Hashemite Kingdom of Jordan 2004). On high elevations, temperatures may drop below zero during the winter months and snowfall is relatively frequent on Jabal ash-Shara. Not only the seasonal but also the diurnal variation of temperature and humidity is great (Lane and Bousquet 1994: 23). In Wadi 'Araba, the temperatures are considerably higher year round than in the mountainous areas or the eastern highlands.

The differences in temperature and the availability of water as a result of differential geomorphology, lithology and rainfall lead to great variability in the plant world. The Petra region is the meeting point of four phytogeographic regions, namely the Mediterranean, the Irano-Turanian, the Saharo-Arabian and the Sudanian.

Most of the Petra region, including the Jabal ash-Shara area, the western part of the highlands and the Wadi 'Araba Escarpment, is characterized by Irano-Turanian open shrub steppe. The main steppe taxa include *Artemisia herba-alba*, *Hammada salicornia* and *Anabasis articulata*. *Noea mucronata* and *Peganum harmala* invade the artemisia steppe degraded by the grazing of goats. *Thymelea hirsuta, Ephedra campylopoda* and *Ononis natrix* are also common semisteppe elements (Fall 1990: 274). Squill *(Urginea maritima)* can be found on degraded soils. At higher elevations there are occasional stands of degraded Mediterranean type juniper (*Juniperus phoenicea*) and Palestine oak *(Quercus calliprinos)* forests (Fig. 3; Künne and Wanke 1997: 243–51; al-Eisawi 1985: 53–54; Lane and Bousquet 1994: 34).

In Wadi 'Araba, there are both Saharo-Arabian and Sudanian vegetation components, with white broom bush *(Retama raetum)* and acacia trees *(Acacia sp.)* among the other species (al-Eisawi 1985: 55–56). Large wadis with a high water table, especially in the Wadi 'Araba Escarpment, also support hydrophytic vegetation including tamarisk (*Tamarix nilotica*) and oleander (*Nerium oleander*). Occasionally there are also fig trees *(Ficus sp.)*, pistachios (*Pistacia atlantica*/*khinjuk*) and *Cretaegus aronia* trees. Pistachios and Palestine oak can also be found at spots in the sandstone massifs of the Wadi 'Araba Escarpment (Fall 1990: 274; Künne and Wanke 1997: 243–51; Lane and Bousquet 1994: 34). In the eastern predesert area, Saharo-Arabian desert vegetation is predominant and concentrates in the wadi channels (Abudanh 2006: 6).



Figure 3. A forest of mainly Palestinian oak in the al-Hisha region, northeast of Bayda. (Photo: P. Kouki.)

Hydrology and erosion

The major factor controlling plant, animal and human life in a semiarid area like Petra is the availability of water. The streams are ephemeral, flowing only for short periods during and immediately after rainstorms. The strong seasonality of rainfall means that the wadis are dry for most of the year The combination of brief but intense rainfall and sparse vegetation leads to high surface run-off rates (Bull and Kirkby 2001: 9). During rainstorms, the rapid concentration of run-off water into channels can cause flash floods (Hassan 1985: 55–56). On the other hand, as rainfall often lasts only a short time, much of the run-off may infiltrate the slopes already before reaching the wadi, or seep into the loose alluvium of the wadi bed (Bull and Kirkby 2001: 6; Beven 2001: 63).

Climate change and human land use can potentially trigger major changes in flood magnitude and frequency (Bull and Kirkby 2001: 7). Activities such as felling of trees, clearing the land for cultivation and changes in agricultural practises may result in increased erosion. On the other hand, certain types of cultivation practices and plants may help to bind the soil and reduce the erosion potential (Morgan 1986: 61; Beven 2001: 67).

The relationship between human land use and erosion has received much attention in Eastern Mediterranean archaeology. Attempts have been made in Greece to explain quite long and complex cultural sequences by periods of landscape instability triggered by over-exploitation of the land and/or poor agricultural practices (Pope

and van Andel 1984; Jameson *et al.* 1994: 348–414; Zangger 1992). While the role of humans in changing the environment can hardly be dismissed, the problem of these models tends to be the over-simplification of the interaction between human land use and the environment, which is far from a simple causal relationship (see the critique in Endfield 1997; Acheson 1997). Similarly, research in the Decapolis region in northern Jordan has shown that it is unlikely that ancient land use or climatic change caused catastrophic erosion or desertification that would have led to site abandonment. The erosion events in the region seem to be connected with periods of prolonged drought, punctuated by extreme rainfall events, rather than with human activity (Schmidt *et al.* 2006).

In most parts of the Petra region, and particularly in the Jabal ash-Shara area and the Wadi 'Araba Escarpment, the soils are vulnerable to erosion due to the steep topography and characteristics of rainfall. Furthermore, the soils are nutrient-poor and therefore vulnerable to nutrient exhaustion while under cultivation, which prevents the spread of natural vegetation in abandoned cultivated areas, which in turn can lead to the depletion of plant cover and erosion (Besançon 2010: 34–36. Different crops also have a different effect on soil erosion potential (Morgan 1986: 4, 51, 61). Studies of run-off generation in modern fields have shown that the least run-off is generated when olives are grown with a seminatural understorey. Correspondingly, the highest run-off is produced on fields with perennial crops using mechanical tillage and weed control (Beven 2001: 67). Therefore, changes in agricultural practices and cultivated plants may also have resulted in such consequences as the intensification of run-off and erosion, which were probably not anticipated by the ancient farmers.

As in the case of palaeoclimatical studies, a major problem of connecting environmental phenomena, such as erosion, and human activity, is the temporal resolution of the environmental data, which is rarely high enough for reliable correlations with archaeological evidence. Furthermore, the results of human actions can often be twofold, in some respects preserving the environment, while in others damaging it. For example, the construction of terraces and wadi barrages is generally considered to reduce the risk of erosion. However, in a study conducted in Greece, it was found out that although terracing can reduce erosion caused by surface runoff and gullying, it may, in fact, increase the risk of slumping on certain types of soils (Rackham and Moody 1992: 124). Likewise, in the UNESCO survey of the floodfarming systems in Libya, it was noted that the building of cross-wadi barrages on valley floors concentrated flow in certain areas, which became heavily gullied as a result (Gilbertson *et al.* 2000: 150). On the other hand, research in the Negev indicates that many of the terraced wadis have not suffered erosion even after the abandonment of cultivation (Bruins 1990: 97). Thus, it can be concluded that the consequences of terrace abandonment are not always the same, but depend on various factors, such as the amount of rainfall and runoff, the steepness of the slope and the channel gradient, which may vary greatly even within a relatively small region.

More widespread erosion could be caused by climatic change, as in the Decapolis region, but extensive environmental studies have not been carried out in the Petra region. The results of the sedimentological studies in the Jabal Harun area tentatively

suggested a period when the rate of erosion was moderate and deposition of sediment took place relatively slowly, starting during the Iron Age at the latest and continuing until sometime after the Nabataean-Roman period, followed by erosion and degradation for the major part of the historical period (Kouki 2006: 158–59). However, due to the topographical character of the Jabal Harun area – a small headwater catchment – it is questionable whether these results can be extended any further afield.

5.2 Past environmental changes

Although there is a growing body of data on the past climate of the Near East, the results from different studies are often ambiguous. It appears that the climate has varied considerably within a relatively small geographical area and the changes in climate have not been simultaneous or even similar over the entire Near East. The main discrepancy in the palaeoclimatic record seems to be between the northern parts (Turkey, Iran) and the countries of the southern Levant, suggesting at least partially different climatic controls over these areas (Hunt *et al.* 2007: 1332), which indicates that results from one cannot be reliably used as a proxy for the other. However, at least as long as the climatic controls over the southern Levant have remained the same as at present, i.e., for most of the Holocene period, it can be expected that the distribution of rainfall in the southern Levant has also resembled that of the present day.

Another complication for an archaeologist, especially for one working within the tightly dated Classical and post-Classical periods, is the temporal resolution of palaeoclimatic data, which is generally within centuries at best. Furthermore, different research methods produce data of variable temporal and climatic resolution, which may cause a seeming discrepancy and complicate the combination of palaeoclimatic data from various sources. During the later Holocene, the climatic oscillations in the Near East have also been of a smaller magnitude, which makes them more difficult to discern in different palaeoclimatic records.

Sources for palaeoenvironmental reconstruction in the southern Levant

Relatively little palaeoclimatic data is available from Jordan, and even less for the southern part of the country, including the Petra region. The data available is largely from the northern parts of the country, like the Lake Lisan sediments (Abed 1985; Abed and Yaghan 2000; Landmann *et al.* 2002) and the wadi fan sediments in the Jordan Valley–Wadi 'Araba (Vita-Finzi 1969: 83–88; Henry 1986). Geoarchaeological studies have been carried out in Wadi al-Hasa (Copeland and Vita-Finzi 1978; Schuldenrein and Clark 1994, 2001; Hill 2000) and in the northern and northeastern parts of Jordan (Garrard *et al.* 1994; Palumbo *et al.* 1996; Maher and Banning 2002). The data, which specifically concerns southern Jordan, has been summarized earlier by MacDonald (2001: 374). For the area south of Wadi al-Hasa, palaeoenvironmental information is available from the Ras an-Naqb area (Henry *et al.* 1981), Wadi Faynan (Hunt *et al.*

2007; Barker *et al.* 2007a), southeastern Wadi 'Araba (Niemi and Smith 1999, Smith *et al.* 1997) and for the prehistoric periods in the Petra region (Gebel 1992; Byrd 1989: 16-18). Additional data relevant for southern Jordan is available from the studies of the isotopic composition of corals in the Red Sea (Moustafa *et al.* 2000; Arz *et al.* 2006).

However, there are more sources of palaeoclimatic information available in studies on the western side of the Wadi 'Araba - Jordan Rift. Climatic indications of carbon and oxygen isotopic composition in speleothems have been studied in caves of Soreq and Ma'ale Efrayim in Israel (Bar-Matthews *et al.* 1997, 1999; Vaks *et al.* 2003; Orland *et al.* 2009). Fluctuations in Dead Sea levels have been studied from different sedimentary contexts (Frumkin *et al.* 1994; Frumkin and Elitzur 2002; Enzel *et al.* 2003; Bookman *et al.* 2004). Various palaeoclimatological studies have also been carried out in the Negev desert: palaeosoil formation (Goldberg 1981, 1994; Goodfriend and Magaritz 1988), palaeohydrology of wadis (Frumkin *et al.* 1998), Early Pleistocene lake deposits (Ginat *et al.* 2003) and Late Pleistocene arboreal vegetation (Baruch and Goring-Morris 1997).

Palynological studies provide information on both climate and vegetation history. They have been carried out at various locations in the Near East, but as noted above, the data from Turkey and Iran cannot be reliably used as proxies for the southern Levant. The pollen cores closest to southern Jordan have been studied from the Hula Basin (Horowitz 1979: 217–30; Bottema and van Zeist 1981; van Zeist and Bottema 1982; 1991), from Lake Gennesaret/Kinneret (Horowitz 1979: 231–33; Baruch 1990), and from the Dead Sea Basin (Horowitz 1979: 234–36; Baruch 1990). Palynological studies have also been carried out on sediments at many archaeological sites (e.g., Horowitz 1979: 245–54, Leroi-Gourhan 1982), but these results are problematic for inferring the whole picture of vegetation in the surroundings of the site because of the selective formation of the pollen record at archaeological sites (van Zeist and Bottema 1991: 115). Until recently, much of the palynological and palaeobotanical work in the area has been concerned with the vegetation change during the Pleistocene–Holocene transition, the recognition of early agriculture and the introduction of new crops (Bottema 1999: 10). Furthermore, the palynological data available for the later Holocene cannot be reliably connected to the climate, as the changes in the vegetation are more likely to be the result of human activities such as cultivation and the clearing of forests.

The following reconstruction of the palaeoclimate of southern Levant is mostly based on sedimentological and palynological research, lake level studies and research on the isotopes of cave speleothems. Data independent of archaeological evidence has been preferred, since it is felt that climatic reconstruction based on the presence or absence of archaeological evidence is highly likely to lead to a circular argument. The changes towards wetness or aridity are compared to the previous and next phase, or to the present-day climate, and should be considered relative rather than absolute.

Climate history of the southern Levant from the Last Glacial to the present

Several climatological studies have now shown that the notion that glacial and interglacial periods in Europe corresponded to cool and rainy pluvial periods and warm

and arid interpluvials in the Near East is oversimplified, and there have also been considerable fluctuations in the climate during the last (Würm) glacial. After a wet period ca. 30,000–22,000 years ago (Bartov *et al.* 2002: 19; Gladfelter 1997: 382–83),[13] cool and relatively arid climatic conditions prevailed during the Last Glacial Maximum (ca. 22,000–17,000 BP; Bar-Matthews *et al.* 1997: 161–64; Bartov *et al.* 2002: 19). It seems that the climatic trend was similar to that of the present, meaning that the southern parts of the Jordan Rift were more arid than the northern parts (Abed 1985: 90).

As glaciers in Europe melted, temperatures gradually started to rise and precipitation also increased in the Near East (Bar-Matthews *et al.* 1997: 164; Baruch and Bottema 1991: 16; Landmann *et al.* 2002: 55). Precipitation was probably less seasonal than at present, with comparatively drier winters and wetter summers (Roberts and Wright 1993: 198–99). The development towards a warmer climate was not continuous, but there were large-scale fluctuations, e.g., during the Younger Dryas (ca. 13,000–11,500 cal BP), when a worldwide reversal to glacial conditions took place (Bar-Matthews *et al.* 1997: 164–66; Baruch and Bottema 1991: 16–17).

The climate of the early Holocene, corresponding to the beginning of the Neolithic period, was again considerably wetter than at present (Bar-Matthews *et al.* 1997: 165; 1999: 91; Baruch and Bottema 1991: 17; Fontugne *et al.* 1994: 83).[14] Very arid conditions seem to have prevailed during most of the Pottery Neolithic and Early Chalcolithic periods (Migowski *et al.* 2006: 425–26). Most of the Early Bronze Age falls into the most humid climatic phase during the later Holocene, but after that the climatic amelioration has been of lesser amplitude (Frumkin 1997: 242–44; Enzel *et al.* 2003: 268; Frumkin and Elitzur 2002: 337). Shifts into more humid conditions, punctuated by aridification, occurred during the Middle and Late Bronze Age (Frumkin and Elitzur 2002: 337). From around 1200 BC a climatic trend towards increased aridity prevailed until the 3rd century BC, and the climate of the Iron Age and Persian periods may have been even more arid than at present (Frumkin 1997: 243–44; Frumkin and Elitzur 2002: 337–38; Bookman *et al.* 2004: 565–66).

Rising levels of the Dead Sea indicate a relatively humid period starting in the 3rd or early 2nd century BC and culminating in the 1st century BC (Bruins 1994: 307–308; Frumkin 1997: 244; Bookman *et al.* 2004: 566). Palaeohydrological studies in the northern Negev point towards increased flood frequency around the end of the 1st century BC, related either to the strengthening of the Mediterranean winter regime or the Red Sea Trough system (Frumkin *et al.* 1998: 108–109). It seems that this period was significantly more humid than the present-day climate, although it is not comparable to the earlier Holocene wet periods (see Frumkin 1997: 244). The results of dendrochro-

[13] In Jordan this period was considerably wetter than the present, as indicated by the existence of lakes and marshes in the Azraq Basin (Abed *et al.* 2008), Wadi al-Hasa (Schuldenrein and Clark 1994: 46; Coinman 2004: 79–80, 93) and the Jafr Basin (Abed and Yaghan 2000: 30).

[14] Rainfall may have been nearly twice that of the present day, and it has been suggested that heavy rainstorms occurred throughout the year (Bar-Matthews *et al.* 1997: 165; see also el-Moslimany 1994: 122, 129). However, the palynological evidence is somewhat contradictory. Although the forests expanded again, the earlier deciduous oak forests seem to have been replaced by evergreen oak and other Mediterranean type vegetation, which might be explained by the climate beginning to resemble that of the present day, i.e., rainy winters and dry summers (Baruch and Bottema 1991: 17).

nological studies of wood from the Roman siege ramp at Masada have been considerd as evidence that this period was also cooler (Issar and Yakir 1997; cf. the critique in Lev-Yadun *et al.* 2010).

The isotope data from the Soreq Cave speleothems suggests that rainfall may have been already decreasing after the 1st century AD (Orland *et al.* 2009: 34). A short drop of the Dead Sea level in the 1st–2nd centuries AD is based on the research in Mount Sedom caves, followed by another lake level rise in the 2nd–3rd centuries AD (Frumkin 1997: 244).[15] There is archaeological evidence from excavations at En Gedi, on the shore of the Dead Sea, that an Early Roman bath house was covered in sterile alluvial and Dead Sea sediments by AD 300 (Hirschfeld 2004: 134). This high level of the Dead Sea seems to be followed by a drop in the sea level by the early 5th century (Frumkin 1997: 244). The speleothem isotopes from the Soreq Cave also point towards a steep drop in the amount of annual rainfall around AD 400. Based on the speleothem isotope data, it seems that at the same time, periods of drought became more common, and wet periods became more infrequent than before (Orland *et al.* 2009: 33–34).

The timing of the onset of the aridification of climate is somewhat disputed. Hendrik J. Bruins (1994: 308) considered the entire Byzantine period, beginning from the 4th century, as one of gradually increasing aridity. While most research supports the gradual drying of the climate after the 4th century (Frumkin 1997: 244; Orland *et al.* 2009: 34; cf. Enzel *et al.* 2003: 268, who date the onset to the late 5th century), there is some evidence for the continuity of the relatively humid climatic phase into the Byzantine period. Bookman *et al.* (2004: 566) have identified a high level of the Dead Sea in the 4th–5th centuries based on a radiocarbon date between AD 340–470 from an organic sample within lacustrine sediments. They date the following drop of the sea level to the period after the 5th century, when there is a long erosional hiatus in the sedimentary sequence.

A relatively wet climate during the Byzantine period has also been inferred for Wadi Faynan based on sedimentological and microfossil evidence of the existence of standing water behind a large barrage for long periods of time (Hunt *et al.* 2007: 1329–330). Christoph Heim *et al.* (1997), who studied pollen from Dead Sea sediments, suggested a wetter climate during the Roman and Byzantine periods based on the high frequency of pollen from cultivated plants and the presence of laminated sediments. There are no radiocarbon dates from the upper part of the sedimentary sequence, but the lower part of the sequence covers the Early to Late Roman periods. Arie S. Issar (1998: 123–24) has likewise suggested that the climate of the Roman-Byzantine period was mainly cool and humid, but his conclusion is apparently based on the oxygen isotope data from Lake Van in Turkey, which, as noted above, cannot be reliably projected onto the southern Levant because of the differences in the climatic controls over the two areas. Hirschfeld (2004: 133) has even pushed the start of a more arid climatic trend to as late as the 7th century. However, the sources he quotes – e.g., Bookman *et al.* 2004 – do not, in fact, support this interpretation.

[15] Klein (in Bruins 1994) suggested a peak in the 1st century BC, followed by drop in the 2nd century AD, but his curve for this period is fragmentary. See also the critique in Frumkin (1997: 244).

Regardless of the uncertainty concerning the timing of the beginning of climatic aridification, it is generally agreed that the dry climatic trend culminated in the first half of the Early Islamic period, from the 7th to the 9th century, when conditions were probably more arid than at present. From the 10th century onwards, more humid conditions once again prevailed until the 13th century (Frumkin 1997: 244; Frumkin *et al.* 1998: 108; Geyh 1994: 135; Bruins 1994: 308–309; Bookman *et al.* 2004: 567–69).

R. Touchan and M. K. Hughes (1999) have made a reconstruction of precipitation in southern Jordan for the period between AD 1600–1995, based on dendrochronological sequences of *Juniperus phoenica* from the Dana Reserve and Tor al-Iraq. Their results are particularly interesting for understanding the occurrence of droughts in southern Jordan. Touchan and Hughes noted that the average interval between drought years in the dendrochronological sequences is roughly four years, while the maximum interval was sixteen years (between 1664-1680). Most drought events had a duration of one year, but there were a few events that lasted for two years or longer. On the basis of these discoveries, they concluded that periods of drought longer than five years are unlikely in southern Jordan.

CHAPTER 6 – HUMAN PRESENCE IN THE PETRA REGION FROM THE PREHISTORIC PERIODS TO THE END OF THE IRON AGE

6.1 The Palaeolithic periods

The earliest archaeological evidence in southern Jordan dates to the Lower Palaeolithic (450,000–150,000 bp).[16] There is a concentration of finds in the al-Jafr Basin (Rech *et al.* 2007) and a few sites from other areas, such as Fjaje, near Shawbak (Rollefson 1985), and Wadi Qalkha in the Ras an-Naqb area (Henry 1986: 12–14). Sites with Lower Palaeolithic components have been found in the Wadi al-Hasa Survey (WHS; Coinman *et al.* 1988: 48) and in the Tafila-Bysayra Survey (TBAS; Neeley 2004: 36–38). Stray finds of Lower Palaeolithic date have also been made in the Petra region (e.g., 'Amr and al-Momani 2001: 281; Lavento *et al.* 2004: 230).

Evidence of Middle Palaeolithic (150,000–45,000 bp) occupation has been found in Wadi al-Hasa (Coinman *et al.* 1988), the uplands and piedmont area of Wadi Hisma (Henry 1988: 11–15) and the Ras an-Naqb area (Henry 1986: 14–15), as well as throughout the TBAS survey area (Neeley 2004: 39–43). In the Southeast Araba Archaeological Survey (SAAS), evidence of Middle Palaeolithic occupation was found only near the springs of Gharandal and 'Ain Tayyiba (Smith *et al.* 1997: 48–49, 65). In the Petra region, Middle Palaeolithic sites seem to concentrate in the western part of the Wadi 'Araba escarpment. The sites found resemble those in the Ras an-Naqb area, being mainly eroded surface scatters. There are large sites like this at adh-Dhaman (adh-Dhaman 3) and Ras an-Nyazi. A rare example of Middle Palaeolithic artefacts in situ was found at Sunakh 2, near Jabal al-Barra (Schyle and Uerpmann 1988: 39–41). Middle Palaeolithic material also forms the largest group of lithic material in the FJHP survey (Lavento *et al.* 2004: 230).

Upper Palaeolithic (45,000–20,000 bp) sites are well attested in Wadi al-Hasa (Coinman *et al.* 1988; Coinman 2004) and in the TBAS area, where the sites concentrate in the ancient lakeshore environments around Jurf ad-Darawish (Neeley 2004: 39–46). A number of sites are also known in Wadi Hisma (Henry 1988: 15–18) and in

[16] The dates are after Olszewski 2001. Upper case 'BP' signifies calibrated radiocarbon dates, lower case 'bp' uncalibrated ages.

the Ras an-Naqb area (Henry 1982: 427–30), but no conclusive evidence of the Upper Palaeolithic was found in the SAAS (Smith *et al.* 1997:48–49, 65). Only a few sites are known from the Petra area, for example, in Wadi Sabra and Umm al-Alda (Schyle and Gebel 1997: 149–50).

The Epipalaeolithic period

The Epipalaeolithic period (20,000–10,300 bp) is characterized by a diversity of tool complexes and subsistence modes, and there are a number of contemporary technological traditions coexisting in southern Jordan during this period. Numerous Epipalaeolithic sites have been reported in Wadi Hisma (Henry 1988: 18–32), in the Ras an-Naqb area (Henry 1985: 73) and in Wadi al-Hasa (Coinman *et al.* 1988), as well as in the TBAS survey area, where they concentrate in the lakeshore environments of Jurf ad-Darawish (Neeley 2004: 42–43). In contrast, no Epipalaeolithic sites were detected in the area of the SAAS (Smith *et al.* 1997: 49, 65). A number of Early Epipalaeolithic sites are known in the Petra region, for example, in Wadi Sabra and Adh-Dhaman (Schyle and Uerpmann 1988: 52–63). Unspecified Epipalaeolithic material was also detected at nine sites in the Jiththa sector in the WMS, suggesting human presence on the desert margin ('Amr and al-Momani 2001: 278–81). Excluding the Mdamagh rockshelter (Schyle and Uerpmann 1988: 48–49), the Epipalaeolithic sites in the Petra area tend to be small and ephemeral.

The Late Epipalaeolithic corresponds to the Natufian culture (12,800–10,300 BP), which marks the first permanent settlements and the earliest agriculture (Bar-Yosef and Belfer-Cohen 1992: 32). However, in southern Jordan, the character of the Natufian settlement seems to have been different from the Mediterranean core area. The Natufian occupation in Bayda appears to have been a short-term or seasonal encampment with repeated stays for a portion of the year over a long period of time, rather than a sedentary village (Byrd 1991: 258–60). Natufian sites are also known in the Petra region in Wadi Sabra and Wadi al-Mataha and at the foot of the al-Barra massif (Gebel 1988: 73–74).

6.2 The Neolithic period

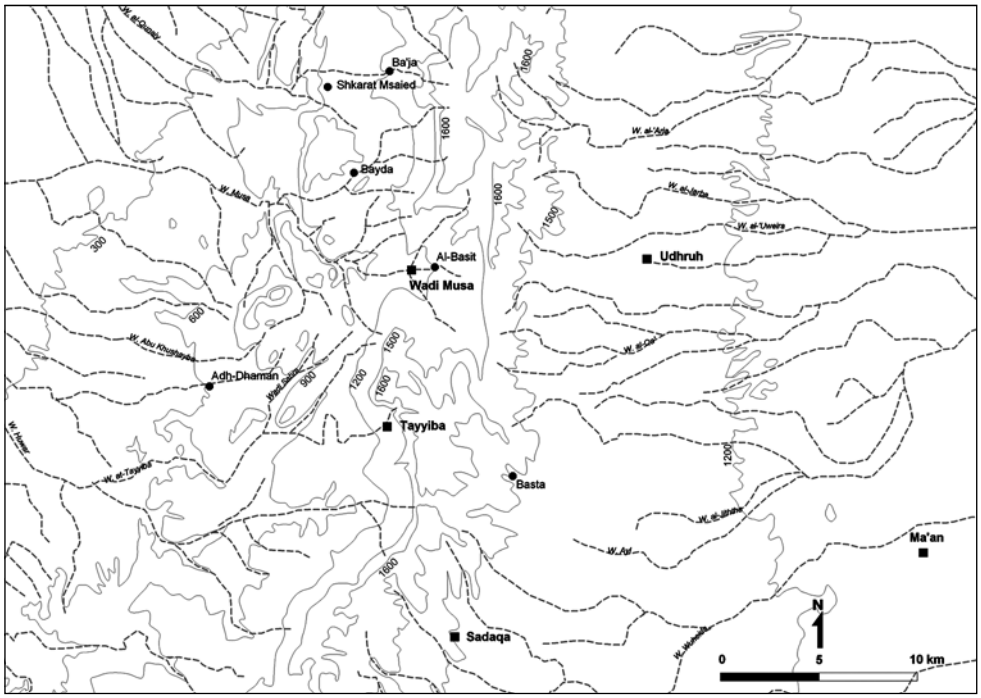
There are only a few known Early Pre-Pottery Neolithic (PPNA; 10,300–9600 bp)[17] settlements in southern Jordan. Most of the sites are either ephemeral or seasonal campsites. In the Petra region, there is one such site (Sabra 1) in Wadi Sabra, where Khimian lithic industry has been identified (Gebel 1988: 78).

For a long time, Bayda (Kirkbride 1966) was the only PPNB (9600–8000 bp) site known from the eastern side of Wadi 'Araba, but in the 1980s and 1990s, several other sites representing the PPNB period were located. In the Petra region (Map 13) excava-

[17] The dates are after Rollefson 2001.

tions have been carried out at the Middle PPNB Shkarat M'saied (Kaliszan *et al.* 2002; Jensen *et al.* 2005), Late PPNB Basta (Gebel *et al.* 1988; Nissen *et al.* 1991: 13), Late PPNB Ba'ja (Bienert and Gebel 1998) and Late PPNB al-Basit in modern Wadi Musa (Fino 1998). In the Wadi 'Araba, PPNB occupation has been found at Adh-Dhaman and concentrated near 'Ain Tayyiba (Smith *et al.* 1997:50). In addition to the settlements, there are scatters and stray finds of lithic material indicating various activities in the landscape such as gathering, hunting and obtaining raw materials for tools and decoration, firewood and building material. These have been found near Bayda, in the Wadi Musa area ('Amr *et al.* 1998: 504, 510, 519), in Wadi Sabra (Gebel 1988: 83) and in the Jabal Harun area (Lavento *et al.* 2006: 22–24). The PPNC period (8000–7500 bp) in Jordan is only known from 'Ayn Ghazal (Rollefson 2001: 86).

The Pottery Neolithic period (7500– 6000 bp) is poorly known in southern Jordan (Smith *et al.* 1997: 51). A few sites were detected in the WHS and in the SGNAS (MacDonald 1992: 157–58), and a Late Neolithic/Chalcolithic settlement was revealed by excavations at Tell Wadi Faynan (al-Najjar *et al.* 1990). No Pottery Neolithic sites were found in the TBAS or in the SAAS, although they have been reported in the Eilat area (Smith *et al.* 1997: 51). In the Petra region, evidence of Pottery Neolithic occupation has been found only at al-Basit, in the modern Wadi Musa area ('Amr and al-Momani 2001: 262–64).



Map 13. The major PPN sites in the Petra region.

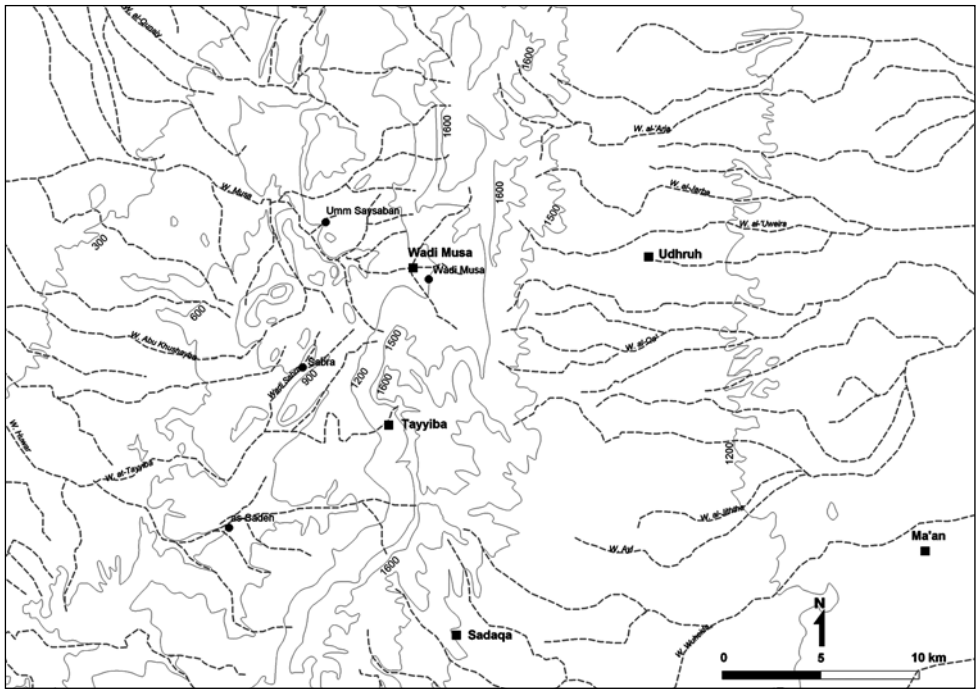
6.3 The Chalcolithic period and the Bronze Age

The distribution of Chalcolithic (ca. 6000–3600 BC)[18] sites in southern Jordan seems to be bimodal, associated with different activities and probably also different population groups. The activity in Wadi 'Araba seems to be largely related to copper extraction, while the highland sites in the east are related to herding and hunting activities. In the SAAS, considerable evidence of Chalcolithic activity and copper smelting was attested along the Wadi Yutm alluvial fan and within Wadi Aheimar (Smith *et al.* 1997: 65). In the Wadi Faynan survey, Chalcolithic settlement is known only at one site in Wadi Fidan, although lithic finds were made in the area and there is evidence of the mining and smelting of copper (Barker *et al.* 2007b: 232). In the TBAS area, the distribution of Chalcolithic sites formed two concentrations: one to the west of the survey area, i.e., towards Wadi 'Araba, and another in the area of the Pleistocene lakes in the east (MacDonald 2004: 54–56). In the Petra region, possible Chalcolithic material has only been reported from a couple of sites in the WMS ('Amr *et al.* 1998: 510; 'Amr and al-Momani 2001: 280), but in Wadi Hisma (Henry 1988: 33–35) and in the Ras an-Naqb area, there is ample evidence of Chalcolithic occupation, apparently with herding as the subsistence base. Large sites with architectural remains are found in the highlands within the Judayid Basin, while the lowland sites are smaller, consisting of thin lithic scatters with no architecture. The Chalcolithic of the Ras an-Naqb area bears a strong affinity to that of the Sinai (Henry 1982: 439–43).

The Early Bronze Age (EBA; 3600–2000 BC) witnessed for the first time the emergence of urban settlements and complex societies in many parts of the Near East. However, the Bronze Age in southern Jordan is very different in character from the northern and central parts of Jordan and resembles more that of the Negev and Sinai (Bienkowski 1992a: 7). No cities existed in southern Jordan, but numerous sites are known in Wadi 'Araba, where the settlement apparently continued from the Chalcolithic period and seems to be connected with the mining and smelting of copper ore (Niemi and Smith 1999: 799–803; Rothenberg and Glass 1992: 141–42). The first phase of intensive exploitation of copper ore in Wadi Faynan took place during the EBA, and there is evidence of permanent settlement including a large, complex site. The earliest evidence of floodwater farming in Wadi Faynan also dates to this period, and pastoral settlements have been found further from the Faynan channel (Barker *et al.* 2007b: 235–51, 257–62). The increase in copper production sites in the Wadi 'Araba from the Chalcolithic to the EBA is considered to be related to the trade between the Near East and Egypt and the main trade routes that passed along Wadi 'Araba and through the Negev and Sinai (Lindner *et al.* 1990: 199–204).

In the Petra region, the EBA settlements and other sites concentrate on the Wadi 'Araba Escarpment (Map 14). They are often not only generally dated, but on the basis of the few dates available, it seems that not all of them were inhabited at the same time (Lindner *et al.* 1990: 193–99; Schaub 1992: 163–64). There is a small settlement in Wadi as-Sabra (Lindner 1992b: 199–200; Lindner and Zeitler 1997/98: 539–42), a settlement

[18] Based on Bourke 2001: 112–13, Table 4.1.



Map 14. Bronze Age settlement sites in the Petra region.

of ca. 25 houses in Wadi as-Sadah (Lindner 1990: 77–79; Lindner *et al.* 1990: 193–99) and remains of buildings on Umm Saysaban (Lindner and Zeitler 1997/98: 542.). Scatters of lithic artefacts and/or pottery sherds have also been recorded in Sabra and on Jabal al-Khubtha (Lindner and Zeitler 1997/98: 542), Jabal Fidre, Jabal Shudayfah (Lindner 1998; Lindner *et al.* 2001: 307–308) and Umm Babayn (Lindner *et al.* 1997: 178), as well as at Ba'ja IV (Bienert *et al.* 2000: 122).

None of the EBA sites in the Petra area are as large as their contemporaries in Wadi Faynan or in the Negev. The settlements are usually located near a permanent source of water, and their character is agricultural and domestic. No metal objects have been found, and the find material consists mainly of lithics, some pottery and stone tools. It seems that animal husbandry (mainly goat) and small-scale agriculture formed the basis of the economy. It has been suggested that these sites may represent semi-permanent, seasonal dwellings (Lindner *et al.* 2001: 308). There is no definite evidence of copper mining in the Petra area during the EBA although ancient mining has been reported from Wadi as-Sabra (Lindner 1992b: 193–201). It seems that during the EBA, the Petra area was not in any significant way involved in the regional exchange of goods (Lindner and Zeitler 1997/98: 542).

Starting from the last quarter of the 3rd millennium BC and accelerating towards the end of the EBA, some, or more likely several, factors contributed to the abandonment of many of the urban centres in northern Jordan and Palestine. It has been postulated that the abandonment led to the relocation of population and a reversion to subsistence farming and pastoralism, indicated by an enormous increase in the number

of small settlements and camp sites during this period, especially in the Negev Highlands (Finkelstein 1989: 130–31), but also in the Jordan Valley and northern Jordan (Prag 1992: 155).

During the Middle and Late Bronze Age (MBA: 2000–1550 BC; LBA: 1550–1200 BC), there were several urban sites in the northern Jordan Valley and northern Jordan (Najjar 1992: 149–53; McGovern 2004: 287, 292). However, towards the south, the number of settlements diminishes (McGovern 2004: 288). During the MBA and the LBA, very little evidence for sedentary occupation, or, indeed, human presence, is known from southern Jordan (Bienkowski 1992a: 6; Smith *et al.* 1997: 56; MacDonald 2004: 281). MacDonald (1992: 157–58) reports no MBA or LBA sites from the SGNAS, nor are there any MBA sites from WHS, but six LBA sites were located in the extreme western part of the survey area (MacDonald 1992: 113, 199). The Wadi Faynan survey located a few MBA and LBA sites, with also some evidence of metallurgy during the MBA (Barker *et al.* 2007b: 270). In the survey of Edom, no sites predating the Iron Age were discovered (Hart and Falkner 1985: 256), nor were any MBA–LBA sites found in the TBAS survey (MacDonald 2004: 56). Likewise, no occurrence of sites from these periods was noted in the SAAS, although there is a LBA presence at a few sites on the western side of the valley (Smith *et al.* 1997: 56, 65). To the rare archaeological occurrences of these periods in southern Jordan can then be added the only site in the Petra region with a reported MBA element, located in the area of the modern town of Wadi Musa ('Amr and al-Momani 2001: 264–65).

Nevertheless, there is no reason to suggest a complete depopulation of southern Jordan during the MBA and LBA, but rather a reversal to a more mobile way of life (Bienkowski 1995: 53). Egyptian written sources dating to ca. 1800 BC mention tent-dwelling, probably pastoral or semi-nomadic people, who were organized in "clans" led by "chiefs" in the area of southern Jordan (Bienkowski 1992a: 3). Pjotr Bienkowski has postulated that the nomadic people of southern Jordan had a close economic connection with the more urban parts of the Levant and were dependent on the trade and surplus produced by the cities. Therefore, the economic efflorescence of the cities of Palestine and the central and northern parts of Jordan during the MBA and the subsequent political instability and economic decline in the LBA also influenced the population in southern Jordan. Bienkowski interprets the sedentary settlements of the LBA in southern Jordan as a sign that, lacking the surplus from the cities, the indigenous people were forced to settle and practice agriculture to produce food (Bienkowski 1992a: 7–8).

6.4 The Iron Age

The existence of Early Iron Age (Iron I: 1250–1000 BC) sites in southern Jordan is a much disputed question. Glueck dated the Iron Age sites between the 13th–8th centuries BC, but later excavations by Crystal-M. Bennett in Tawilan (Bennett and Bienkowski 1995), Busayrah (Bienkowski 2002) and Umm al-Biyara (Bienkowski 2011) have yielded no material datable prior to the end of the 8th century BC.[19] Bienkowski

[19] Finkelstein has argued that some material from the sites excavated by Bennett could be dated to Iron

dates most Iron Age sites in southern Jordan to Iron II with the exception of some sites in the western part of Wadi al-Hasa, which he considers to be possibly earlier (Bienkowski 1992b: 6–7). Lately, Iron Age sites dated to the 9th century BC have also been discovered in Wadi Faynan, where there is evidence of extensive exploitation of copper ore and run-off farming (Bienkowski and van der Steen 2001: 23; Mattingly *et al.* 2007: 273–85).

The area of southern Jordan is known from the 8th century BC in Biblical and Assyrian sources as Edom. Therefore, the cultural phase corresponding to Iron Age II (1000–587 BC) in southern Jordan is usually called Edomite. The area of Edomite culture comprises the region south of Wadi al-Hasa as far as Wadi Hisma (Bienkowski 1992a: 1–3). Later, the territory of Edom may have also extended across the Wadi 'Araba, although the actual nature of the Edomite involvement in the Negev is unclear (Bienkowski 2001: 270–71; Bienkowski and van der Steen 2001). The emergence of the Edomite kingdom has been attributed to the development of the Arabian trade. The control of copper production for trade has also been brought up as a reason for the formation of the Edomite kingdom (Levy 2004: 256–58). Bienkowski considers that the Assyrian state had a significant role as a catalyst in the development of Iron Age Edom. In the Assyrian textual sources, Edom appears as a vassal of Assyria, although Assyrian troops were probably not present in Edom except in 668–631 BC when they entered Edom under Ashurbanibal. Otherwise, there is, however, little evidence of direct contact between Edom and Assyria (Bienkowski 1992a: 3–5).

The expansion of Iron Age settlement seems to have taken place as late as around 700 BC. With the exception of Busayra, the character of the settlements in Edom is predominantly rural and agricultural. They are villages and farms, which are usually not fortified, and it seems probable that part of the population remained seminomadic (Bienkowski 1992c: 99–104). Notably, most of them lack the painted pottery found in Busayra, indicating the sparsity of high status sites. Instead, the sites have yielded plain, thick-walled pottery, which is characteristic of the Petra region (Bienkowski 1995: 56). A specialty of the area seem to be the sites on the Wadi 'Araba escarpment, which are located on almost inaccessible mountaintops, such as Umm al-Biyara (Bienkowski 2011), Jabal as-Suffaha (Lindner *et al.* 1998), Umm al-Ala and Baja III (Lindner *et al.* 1996b: 137). The nature and purpose of the mountaintop sites is unclear. It has been suggested that they were not permanently occupied but served as administrative and/or cultic centres for tribes or clans, maybe for periodical gatherings, or as defensive strongholds in times of unrest (Lindner *et al.* 1996b: 162–63; Lindner and Knauf 1997).

Lately, both Bienkowski and van der Steen (2001; van der Steen 2004) and Levy (2004) have suggested that Edomite society was based on a heterarchical tribal organization composed of kin groups, comparable to that of the 18th century Bedouin, rather than on a hierarchical power structure. These tribes were largely independent, and held together by bonds of co-operation and allegiance to a supra-tribal monarchy at Busayra (Bienkowski 2002: 480; 2011: 124). The considerable variability between settlements and their pottery assemblages is therefore likely to reflect the existence of different tribal economies and traditions (Bienkowski 2011: 125). Recent research has also

I, but Bienkowski strongly disagrees (see Bienkowski 1992b; 1992c: 104–110; Finkelstein 1992a, 1992b).

shown a greater variance in the nature of Edomite mountaintop sites than previously supposed, suggesting that the individual sites served as centres for different tribes, and the archaeological evidence suggests that some of them, like Umm al-Biyara, may indeed have been more permanently occupied (Bienkowski 2011: 123–25).

During the Edomite period the imperial control of southern Jordan shifted from Assyria to Babylon and then Persia, and finally to the successors of Alexander the Great. However, these changes are little reflected in the administration of the region (Bienkowski 2002: 481–82). The evidence for settlement is scarce in the whole of southern Jordan during the Persian (587–332 BC) and the Early Hellenistic (Ptolemaic and then Seleucid rule, 332–198 BC) periods (Bienkowski 1990: 196–97; 1995: 60; Smith *et al.* 1997: 56; Tholbecq 2001: 402). Although a continuity of human occupation from Edomites to Nabataeans has been suggested (Bartlett 1979; Bienkowski 1995: 62; 2001: 270–71; 2002: 481–82), conclusive archaeological evidence is lacking. The more striking, therefore, is the emergence of the Nabataeans, when the landscape suddenly seems to fill with settlements, watchtowers, cultic sites and various other signs of human activity. From this period onwards, the Petra region, probably for the first time in its history, became an integrated part of a much wider realm – first the Nabataean kingdom and then the Roman and Byzantine Empires.

CHAPTER 7 – ARCHAEOLOGICAL DATA ON RURAL SETTLEMENT FROM THE NABATAEAN-ROMAN TO THE EARLY ISLAMIC PERIODS

7.1 Analysis of settlement patterns

In order to elucidate information beyond the conventional distribution maps from archaeological survey data, the analysis of settlement patterns was conducted following the model discussed above in Chapter 2.1. The first part of this chapter establishes the rural settlement distribution, while the second part analyses the site hierarchy and continuity from the Nabataean-Roman period to the Late Byzantine-Early Islamic transition. In the third part of this chapter, the site size and continuity are considered as evidence of land use and landownership using the model adapted from Alcock (1993), as discussed in Chapter 2.3.

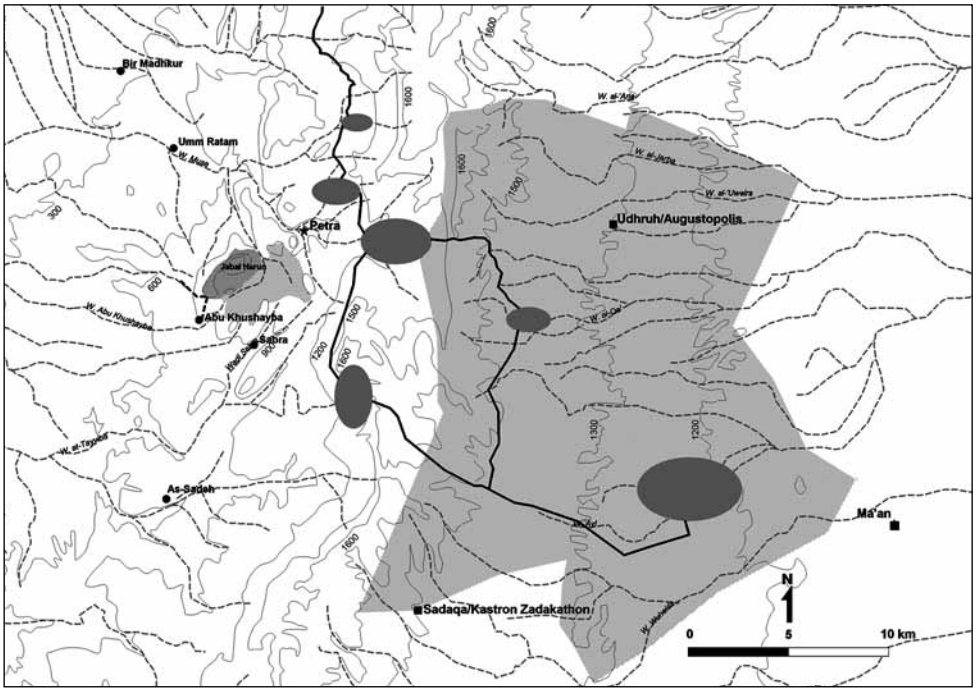
The nature of survey data necessitated the need for selective inclusion of archaeological sites for the analysis. I felt that to recognize gradual changes in settlement patterns, and to be able to judge the reasons behind them beyond simple statements, a higher chronological resolution than that achieved by a division according to conventional archaeological periods was needed. However, the JADIS database[20] entries lack detail in both site description and chronology and, unfortunately, the same goes for the results of many archaeological surveys in the Petra region, for which only preliminary publications are available. This complicates the use of the available data for a detailed analysis of settlement. Therefore, I made the decision not to include in the analysis all the archaeological sites known in the hinterland of Petra, but to use as a sample those surveys for which detailed enough information about the sites was available, meaning the Wadi Musa Water Supply and Wastewater Project survey (WMS; 'Amr *et al.* 1998; Amr and al-Momani 2001) and the survey by Abudanh (2006) in the region of Udhruh. These two surveys were found to adequately cover the core area of this research, and can be treated as representative samples. For the area southwest of Petra, the yet unpublished results of the FJHP survey are available. To balance out the small areal coverage of the FJHP survey, the sites of Sabra (Lindner 1982; Lindner and

[20] JADIS (Jordan Antiquities Database and Information System) is the cultural heritage management database formerly used by the Department of Antiquities of the Hashemite Kingdom of Jordan (see Palumbo 1994).

Zeitler 1997/1998), Abu Khushayba (King *et al.* 1989: 205–207; Lindner 1992), Umm Ratam (King *et al.* 1989: 205–207; Lindner *et al.* 2007), Bir Madhkur (Smith 2005) and as-Sadeh (Lindner *et al.* 1988; 1990: 199) were also included in the data set (Map 15). Several small settlements have been located in Lindner's surveys on the Wadi 'Araba Escarpment and beyond (Lindner 1998; 1999; Lindner *et al.* 2000), and farms and cultivation systems have also been located in the vicinity of the fort at Bir Madhkur (Smith 2005), but the lack of published information about these sites prevented the inclusion of them in the data set.

In order to avoid the problems inherent in the survey data, arising from different methodologies, site definitions and uses of chronological divisions, uniform standards were used for the classification of sites. Initially, it was necessary to decide which sites in the data set qualify as settlements. For the functional classification of sites, I have generally accepted the interpretation given by Abudanh (2006) for his survey, and 'Amr *et al.* (1998) and 'Amr and al-Momani (2001) for the WMS. Where no interpretation was given, mainly in the case of the WMS, I have interpreted sites as settlements if the following conditions are met:

1. There are remains of a building or buildings large enough to have accommodated people; the presence of several wall foundations is a minimum requirement for evidence of a building.
2. There is pottery related to the structure.



Map 15. The coverage of the WMS and the Udhruh region survey by Abudanh and the FJHP survey, and the sites included in the analysis from Wadi 'Araba.

3. There is no evidence (such as site location, presence of sacral architecture and cultic installations) at the site that would suggest a primarily cultic or funerary function for the structures.
4. There is no evidence (such as site location and/or architecture) that would suggest a primarily military use for the site.

Similar consideration was also given to the FJHP sites. The function of a site may have changed over time, but this is difficult to prove with survey data alone. However, if such a change is implied by the survey results, I have taken it into account.

After the selection stage, the sites from each survey were tabulated according to their size and duration of occupation (Table 2). Admittedly, the classification of sites into size categories on the basis of the results of surface survey data is potentially riddled with errors. In many cases, the ancient site is covered by later occupation obstructing the determination of its extent, and the partial preservation of the remains does not allow for an exact count of buildings at the site. Moreover, extensive multi-period sites may have grown or contracted over time, and thus determining their area during any particular archaeological period from surface remains is unreliable. It was also impossible to define site sizes unequivocally by the area covered by the settlement because many sites include other structures besides the building remains, such as cisterns, water channels and adjacent agricultural fields. Bearing all this in mind, I have exercised caution and assigned sites to a smaller rather than a larger size category. The size categories used here for rural sites are as follows:

Small: an isolated building (single farmstead)
Medium: a cluster of two or more buildings forming a hamlet or a large farmstead
Large: an extensive settlement comprising many buildings, such as a village, a suburb or a small town (e.g., Jabal at-Tahuna, Khirbat an-Nawafla)

As compared to Abudanh's (2006: 53–54) classification, which was based on site area, the small sites mainly correspond to his classes of 'farming structure' and 'farmstead', medium corresponds to 'hamlet' or 'small village' and large corresponds to 'large village or town'. However, I have on occasion used judgement based on the site descriptions and placed, for example, a site in Abudanh's hamlet category into the small category if it contains the remains of only one building. There are also occasional inconsistencies in site function and size between the gazetteer (Abudanh 2006: 399–570) and the chronological tables of sites (Abudanh 2006: 204–208, 211–14, 219–22) in his dissertation, and in these cases, I have followed the interpretation that seems more plausible based on the site description. Some of the sites (such as Udhruh/Augustopolis and Sadaqa/Kastron Zadakathon) also had forts or fortresses, but they are still considered settlement sites and calculated into the large site category.[21] The estimations for site

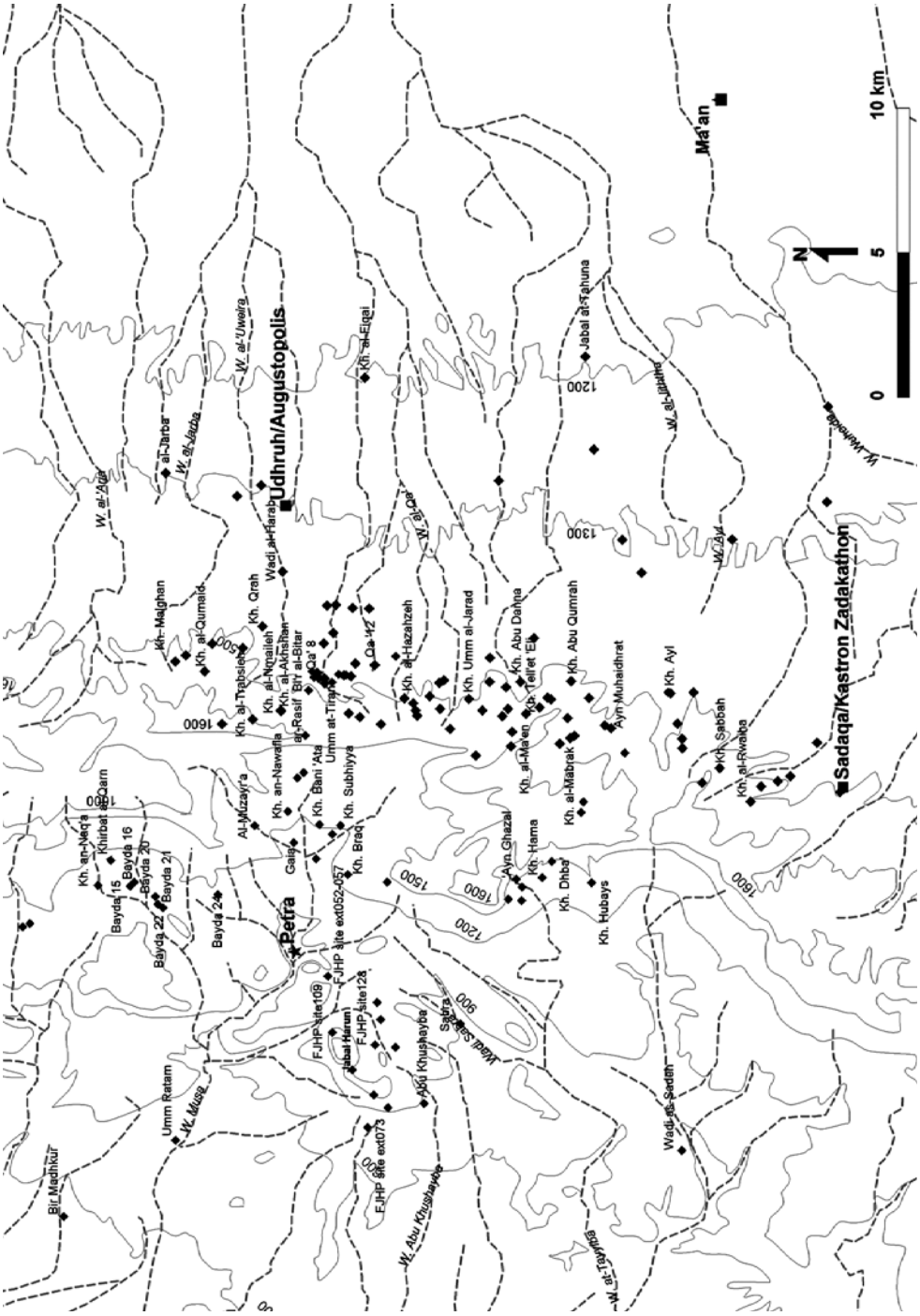
[21] In Sadaqa/Kastron Zadakathon, the fort was apparently separate from the settlement, while in the fortress of Udhruh, established in AD 303/304, the settlement moved inside the fortress after its military use ended (Kennedy and Falahat 2008).

Table 2. Site size and continuity.

	SITE SIZE	2nd BC	1st BC	1st AD	2nd AD	3rd AD	4th AD	5th AD	6th AD	7th AD	8th AD
WMS											
new	S	1	0	15	1	1	0	0	0	0	0
	M	0	0	11	1	1	0	0	0	0	0
	L	0	2	9	0	0	0	0	0	0	0
resettled	S	0	0	0	0	0	2	0	0	0	1
	M	0	0	0	0	0	0	1	1	1	0
	L	0	0	0	0	0	1	1	1	1	0
settlement continuity	S	0	1	1	15	7	3	3	3	0	0
	M	0	0	0	11	10	6	3	1	1	2
	L	0	0	2	11	9	7	8	8	6	4
ABUDANH'S SURVEY											
new	S	0	0	49	6	3	3	0	3	0	0
	M	0	1	14	2	0	0	0	0	0	0
	L	0	0	3	0	0	0	1	0	0	0
resettled	S	0	0	0	0	0	9	1	6	0	0
	M	0	0	0	0	0	2	0	5	0	0
	L	0	0	0	0	0	3	0	1	0	0
settlement continuity	S	0	0	0	47	13	5	17	15	10	5
	M	0	0	1	15	6	3	5	5	5	1
	L	0	0	0	3	3	3	5	6	4	3
FJHP AND WESTERN PERIPHERY											
new	S	0	2	3	1	0	0	0	0	0	0
	M	0	2	5	0	0	0	0	0	0	0
	L	0	0	2	0	0	0	0	0	0	0
resettled	S	0	0	0	0	0	1	0	0	0	0
	M	0	0	0	0	0	1	0	0	0	0
	L	0	0	0	0	0	0	0	0	0	0
settlement continuity	S	0	0	2	4	1	1	0	0	0	0
	M	0	0	2	7	3	2	2	1	1	1
	L	0	0	0	2	2	2	0	0	0	0
TOTAL SITES		1	8	119	127	59	55	47	56	29	17

sizes documented by the WMS are based on the maps and descriptions provided in 'Amr *et al.* (1998) and 'Amr and al-Momani (2001). All the sites included in the analysis are presented on Map 16.

The dating of sites in all these surveys is based on related pottery finds. The general problems related to the pottery-based dating of survey sites were already discussed in Chapter 2.4. However, there are some inherent problems in the chronological division of sites due to the nature of the original data. Sometimes a dating within a century was not available, but the sites were dated only to the archaeological period, such as Early Byzantine. I solved this problem by including them in the count for both the 4th



Map 16. All sites included in the settlement analysis, with the names of the large and medium sites.

and 5th centuries. Similarly, Late Byzantine sites were included in the count for both the 6th and 7th centuries. Moreover, in the original classification by 'Amr *et al.* (1998: 504), the pottery made in the Nabataean tradition was considered both a chronological and cultural marker and classified under one category covering the period from the late 1st century BC up to and including the 3rd century AD. This is reasonable because the annexation by Rome did not cause any abrupt change in the material culture ('Amr 2004: 237). It may, however, cause a slight overrepresentation of sites from the 1st to the 3rd centuries AD in the present analysis, as I have assumed, for statistical purposes, that the use of sites dated only as 'Nabataean' covers this whole period.

The case of the sites from Abudanh's survey was somewhat different again. The pottery analysis was done by 'Amr, but although Abudanh does not explicitly spell out how he has divided the archaeological periods, it is clear from the data he presents in the tables and his discussion of the Late Roman period that he does not consider 'Nabataean' pottery to cover the 3rd century (Abudanh 2006: 210–14). Therefore, for the dating of sites from Abudanh's survey, I have followed the tables in his dissertation if no closer date was given in the gazetteer. Some apparent settlement sites in the gazetteer were, however, missing from these tables, and I have included them.

I have chosen to present the settlement data from the WMS (Fig. 4), Abudanh's survey (Fig. 5), and the FJHP survey (Fig. 6) as separate diagrams. This decision is based on the differences in the areal coverage and methodology of the respective surveys. Moreover, despite the broadly similar outline, there are also significant differences in the rural settlement among the three areas, and these differences need to be illus-

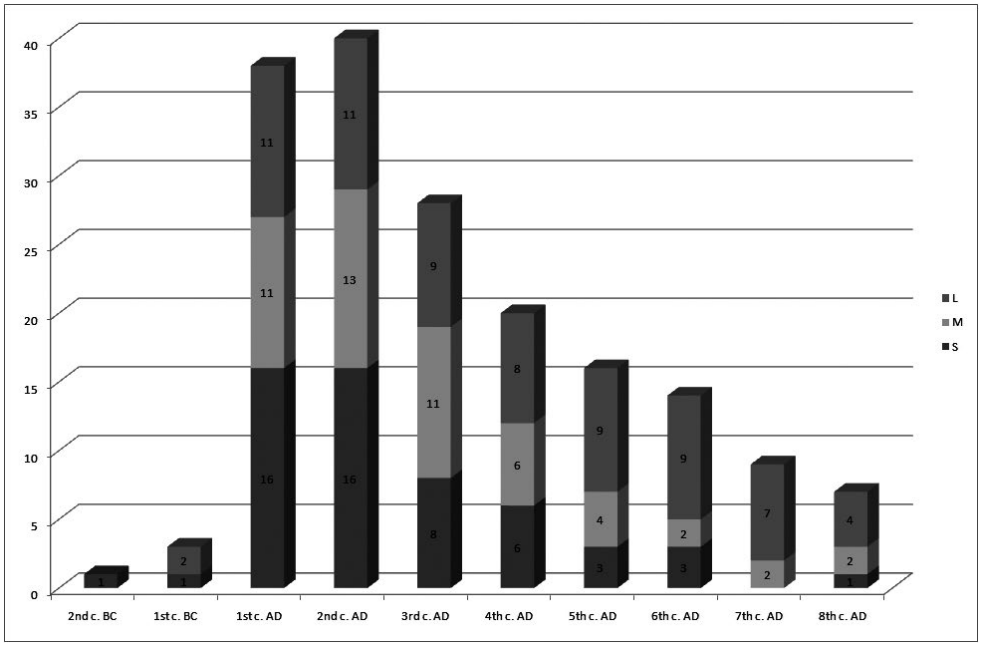


Figure 4. Numbers of settlement sites, documented by the WMS, divided by size categories (large, medium, small).

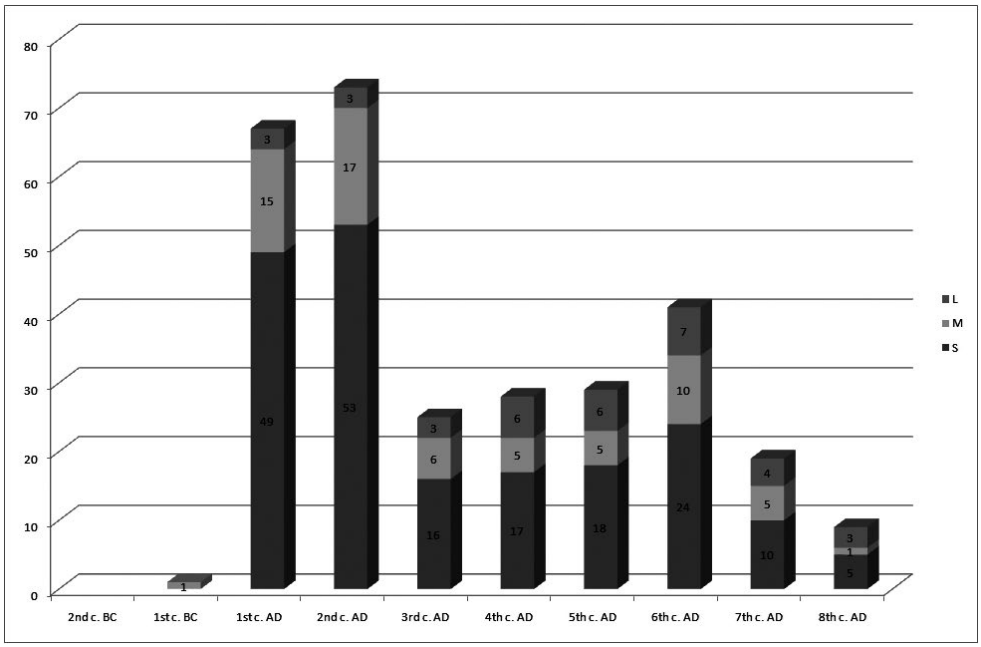


Figure 5. Numbers of settlement sites, documented by Abudanh in the Udhruh region survey, divided by size categories (large, medium, small).

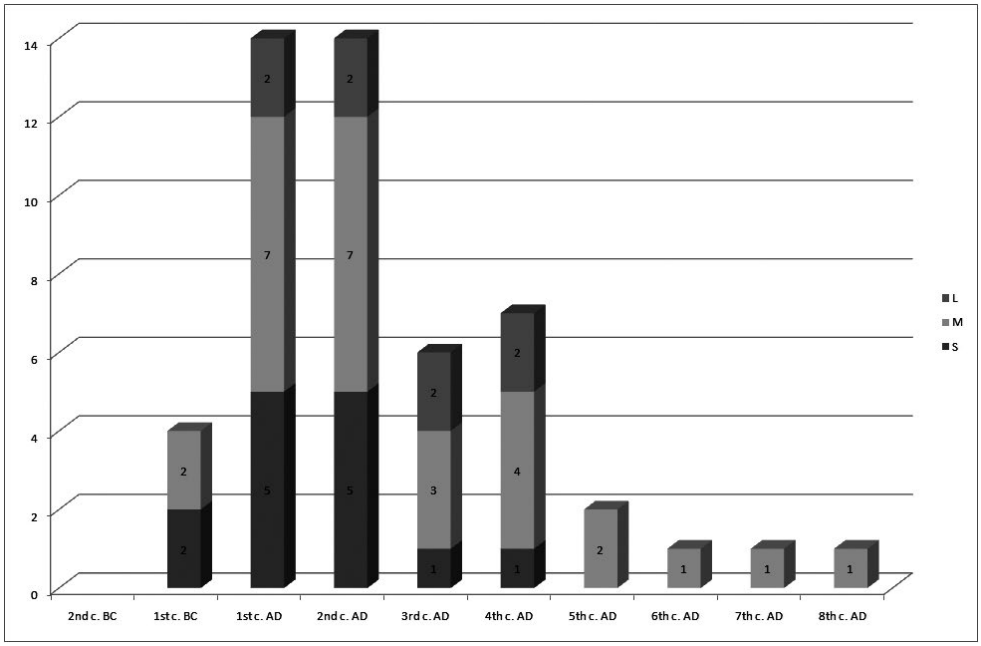


Figure 6. Numbers of settlement sites on the western periphery, including the sites from the FJHP survey as well as Bir Madhkur, Umm Ratam, Sabra and as-Sadeh.

trated. Where the data from Abudanh and the WMS overlapped in the eastern Jabal ash-Shara (the Qa' and Ayl sectors of the WMS), I have included the sites in the WMS site count. Some overlap may still occur due to incorrect identification of the sites, but it is likely to be negligible.

In the following discussion of settlement trends, I have divided the Petra region into four subregions, which correspond to the data from different surveys as follows: the western Jabal ash-Shara area also includes the Bayda area on the Wadi 'Araba Escarpment and thus covers most of the WMS area.[22] The western periphery covers the fringes of the Wadi 'Araba Escarpment (i.e., the FJHP survey area) and the sites in Wadi-as Sabra and in Wadi 'Araba. The sites in the eastern part of the Petra region belong mainly in the area of Abudanh's survey, which is divided into eastern Jabal ash-Shara and the eastern periphery, which covers the highland area approximately from Udhruh to Ma'an (see Map 17).

7.2 Settlement trends from the archaeological data

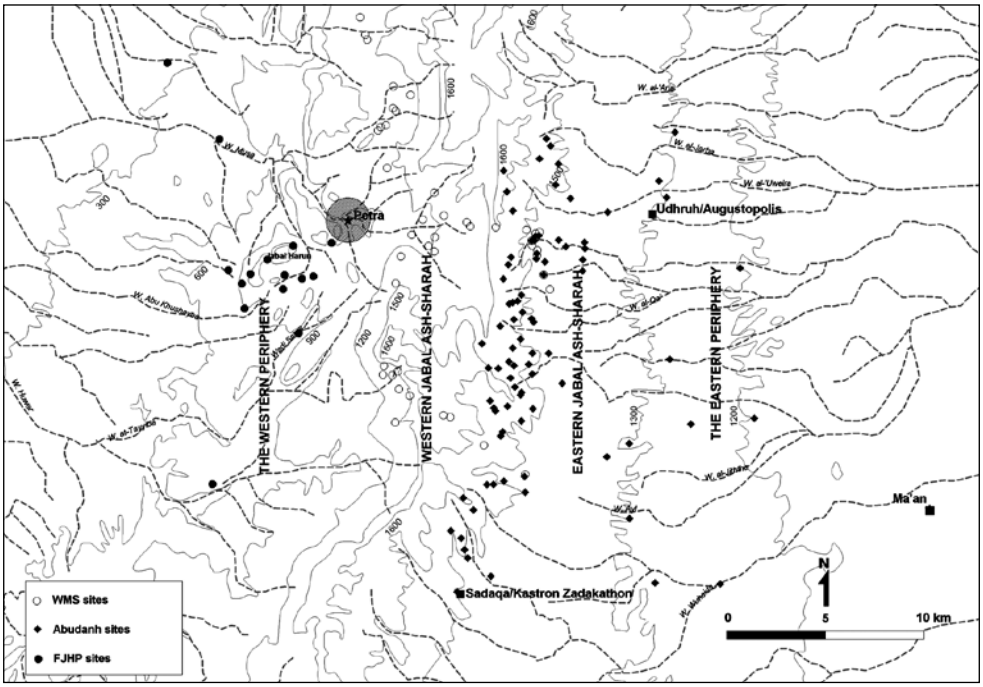
The establishment and expansion of sedentary rural settlement

Barring Petra itself, where the earliest settlement is now firmly dated to the 3rd century BC, the earliest Nabataean settlements in the Jabal ash-Shara area are dated to the late 2nd century BC and later (Wenning 1986: 86; 'Amr *et al.* 1998: 520–24, 529). There are three settlement sites in the Jabal ash-Shara area definitely dated to the 1st–2nd centuries BC in the WMS corpus, and one in Abudanh's data (Figs. 4–5). There are no early settlements on the eastern periphery of the Petra region. On the other hand, there are altogether four early sites on the western periphery of the region (Fig. 6). Most of these early settlements are located close to Petra and/or along the routes leading to the city (Map 18).

If we compare the picture of the site distribution on Maps 18 and 19, it can be seen that a rapid expansion of rural settlement took place in the course of the 1st century AD, when settlements of various sizes sprang into existence all around Petra. The expansion of rural settlement continued into the 2nd century (Map 20), when a slight increase in the number of sites can be observed (Figs. 4–6). These observations are consistent with what has already been suggested earlier (Fiema 1991: 86–89, 279; Graf 1992: 254–55). Not surprisingly, agricultural settlements seem to have concentrated particularly on the Jabal ash-Shara area, which receives the highest rainfall. A suburb of Petra seems to have existed in the modern Wadi Musa area, where luxurious Nabataean 'villas' of the 1st century AD have been excavated ('Amr and al-Momani 2001: 266–67; 'Amr *et al.* 2002).

On the western periphery, settlements appear particularly along the routes leading to Petra, like the sites in the Jabal Harun area. A larger settlement with monumental architecture and cultic structures was established in Wadi Sabra (Hammond 1973: 44;

[22] Note that these subregions do not completely conform to the geographic division of the Petra region, nor the agro-ecological zones discussed in Chapter 8.



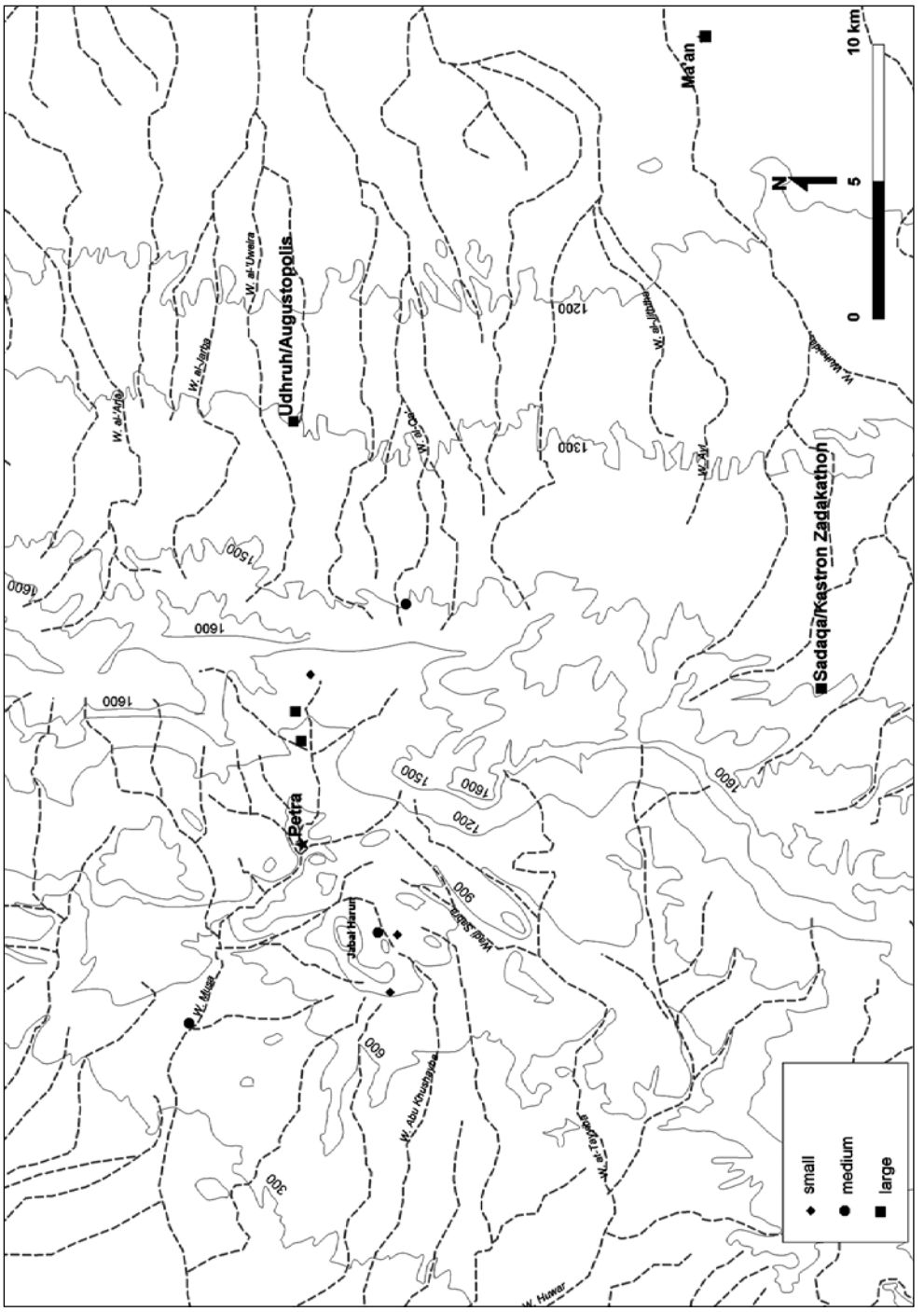
Map 17. The subregions used in the text.

Lindner 1992b: 193, 201; Lindner and Zeitler 1997/98), but there were also hamlets or villages in as-Sadeh (Lindner *et al.* 1990: 199; Lindner 2003: 184–87), Umm Rattam (Lindner 1998: 27; Lindner *et al.* 2000: 549–50; Lindner *et al.* 2007) and Bir Madhkur (King *et al.* 1989: 205; Smith 2005) and a settlement in Abu Khushayba, related to the mining of copper ore (Lindner 1992: 264–65).

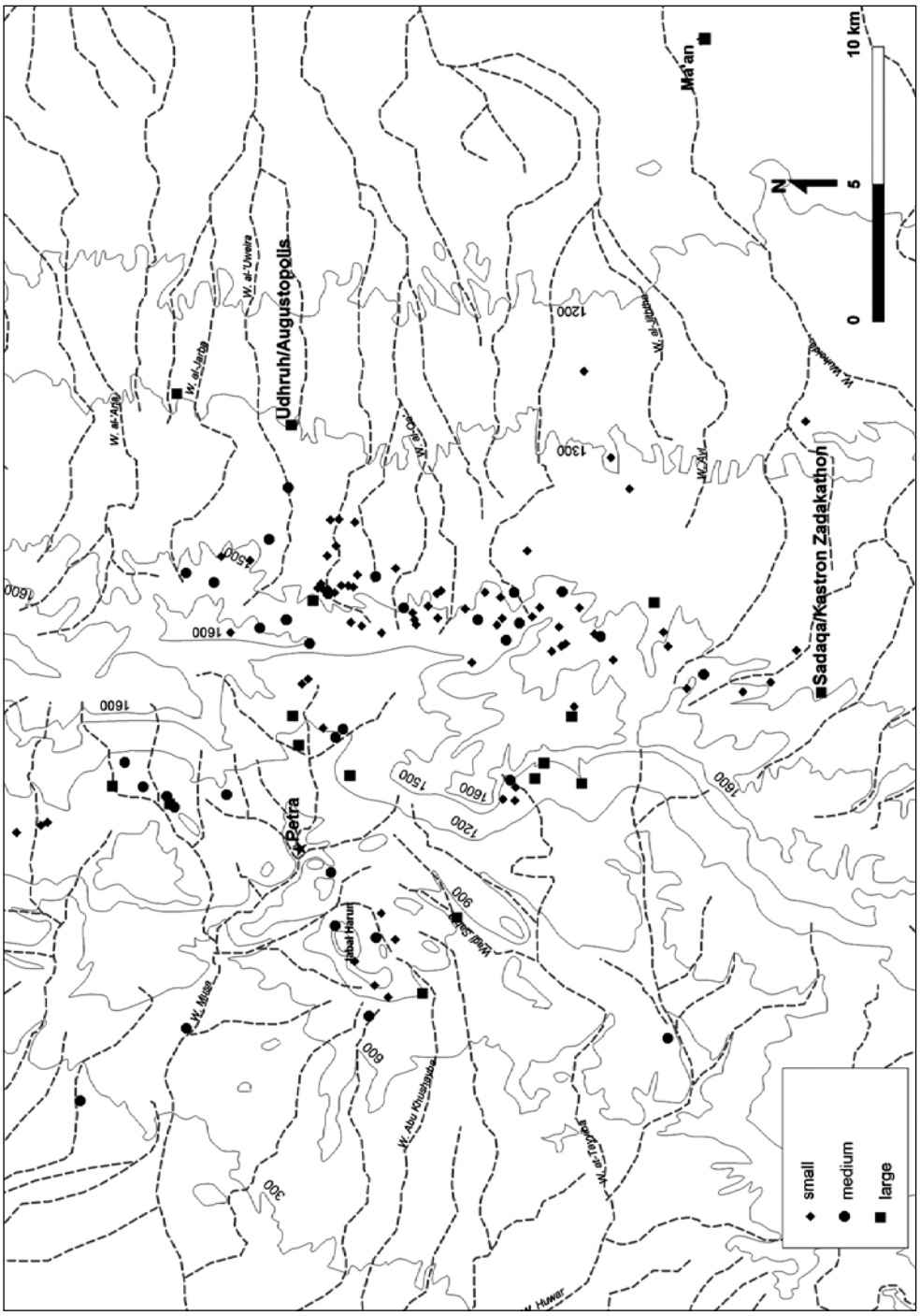
A considerable expansion of settlement onto the eastern periphery of the Petra region also took place during the 1st–2nd centuries AD, mainly towards Udhruh/Augustopolis, but there is also a scatter of sites further south, between Ayl–Sadaqa/Kastron Zadakathon and Ma'an (Maps 19–20). The eastern settlements are mainly small, but there are also some medium-sized sites and possibly even large villages, although the extent of Nabataean settlement at Jarba (Abudanh 2004: 57) and Udhruh/Augustopolis (see Killick 1983) is difficult to establish because of the intensive later activity at the sites.

The contraction and revival of rural settlement

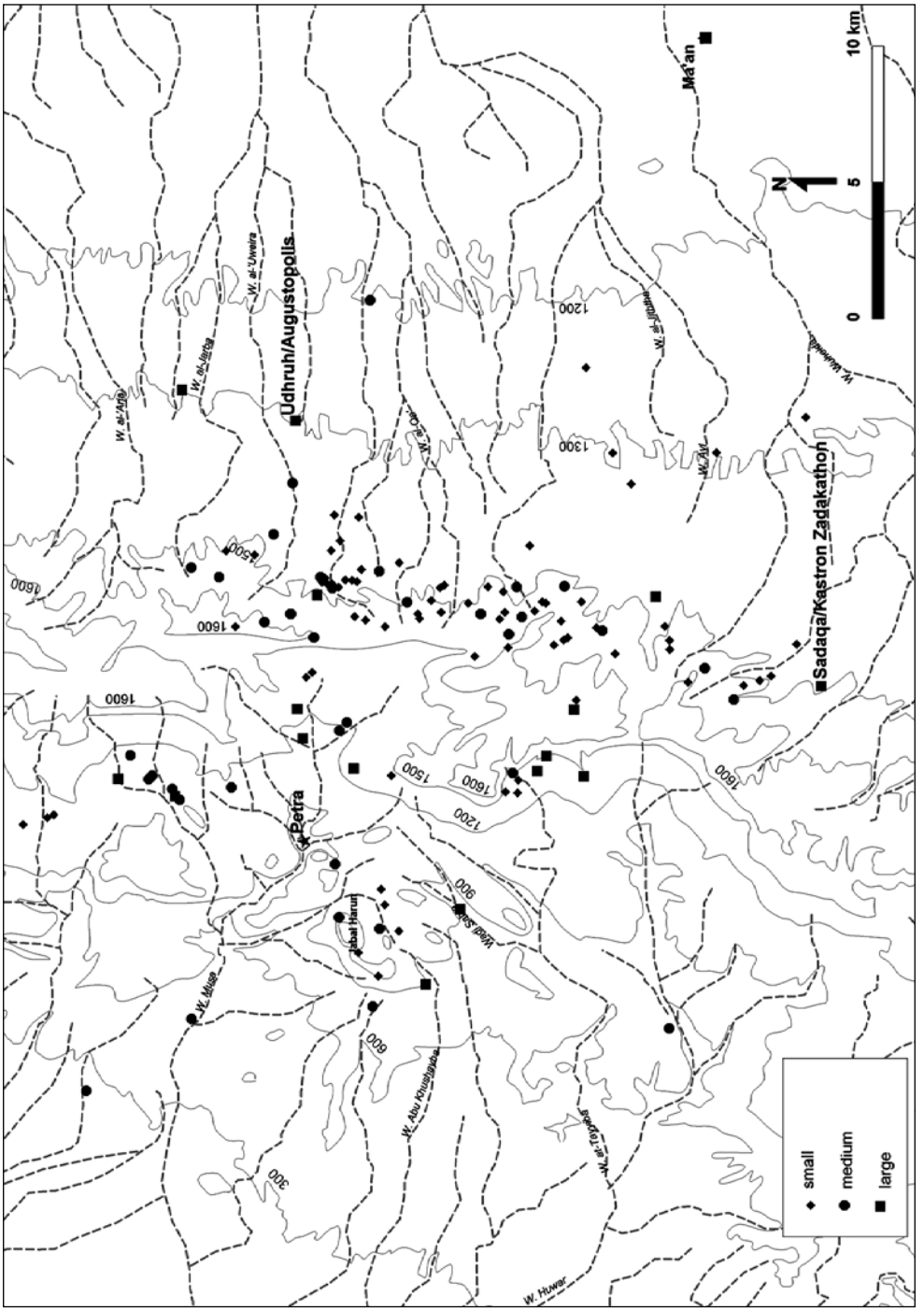
The initial stage of widespread rural settlement did not last long. The most striking phenomenon observable from Table 2 and Figs. 4–6 is the remarkable drop in the number of small settlements that has taken place throughout the Petra region by the 3rd century AD. Only a third of the total of 74 small settlement sites in existence during the early 2nd century continues into the 3rd century. A declining trend can also be



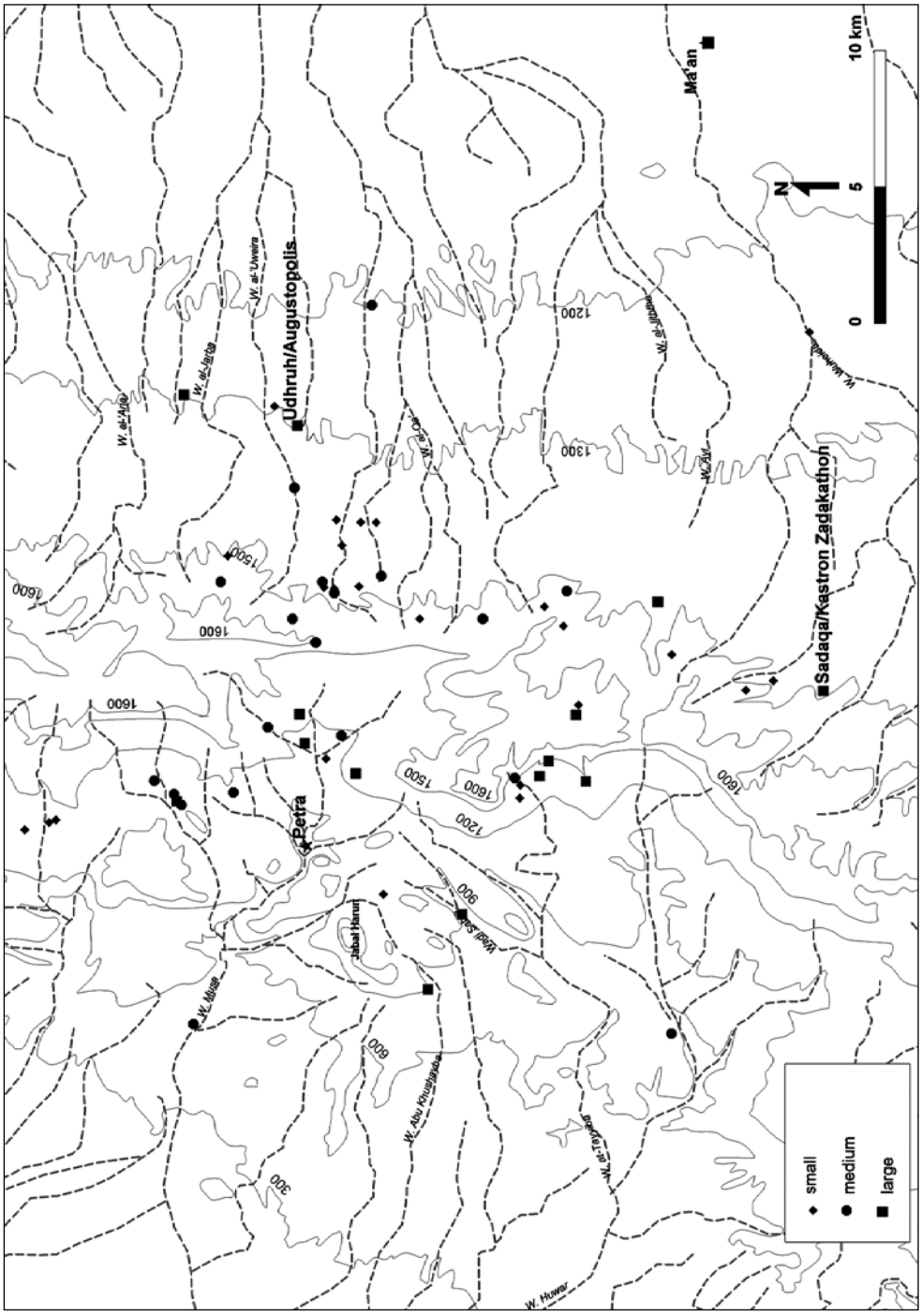
Map 18. The distribution of rural settlement in the 1st century BC.



Map 19. The distribution of rural settlement in the 1st century AD.



Map 20. The distribution of rural settlement in the 2nd century AD.



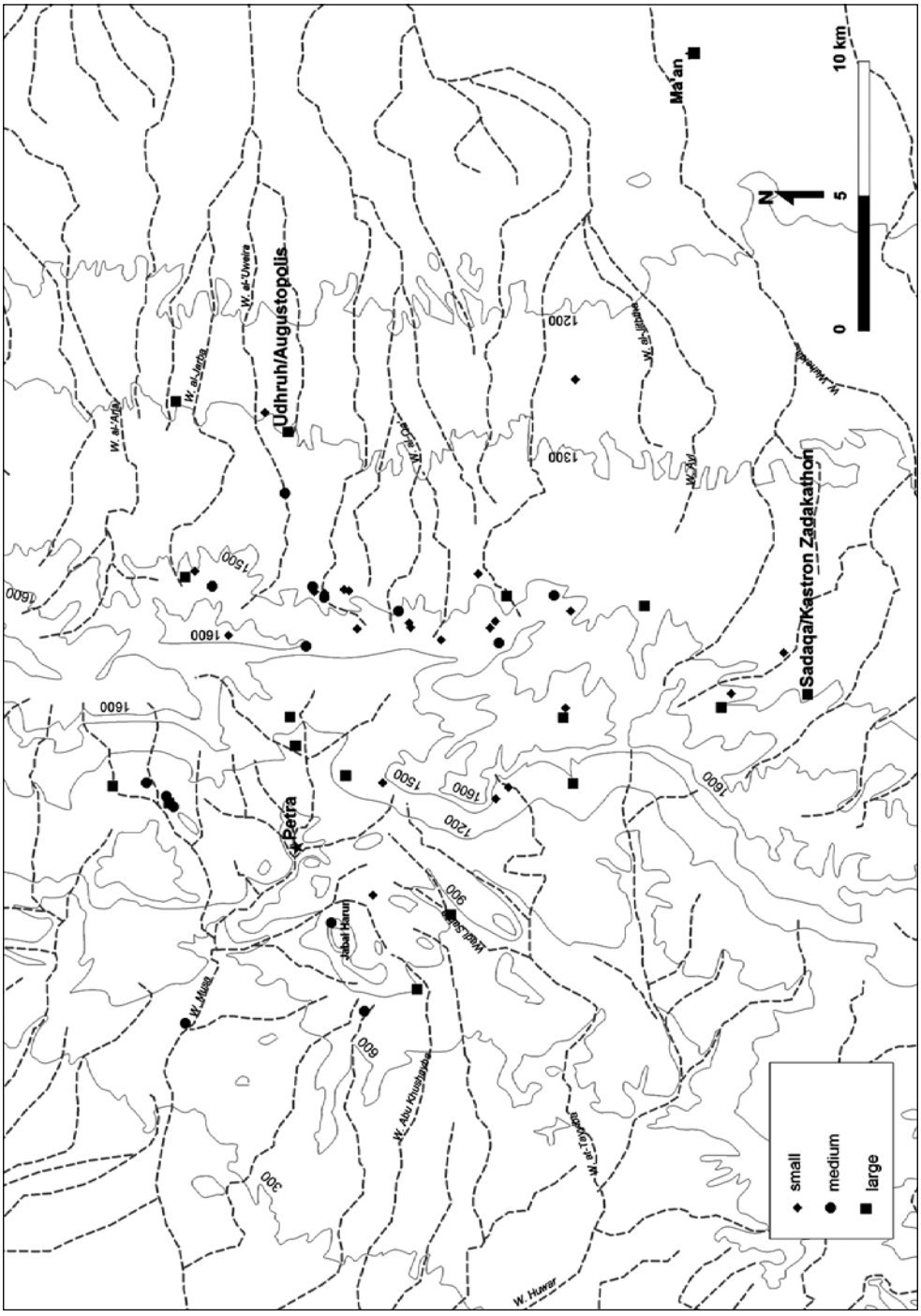
Map 21. The distribution of rural settlement in the 3rd century AD.

seen in the number of medium-sized and large settlements, although the drop is not as sharp as with the small sites. This development is parallel in all areas, although it is more pronounced on the western and eastern peripheries of the Petra region than in the Jabal ash-Shara area (Figs. 4–6; Map 21).

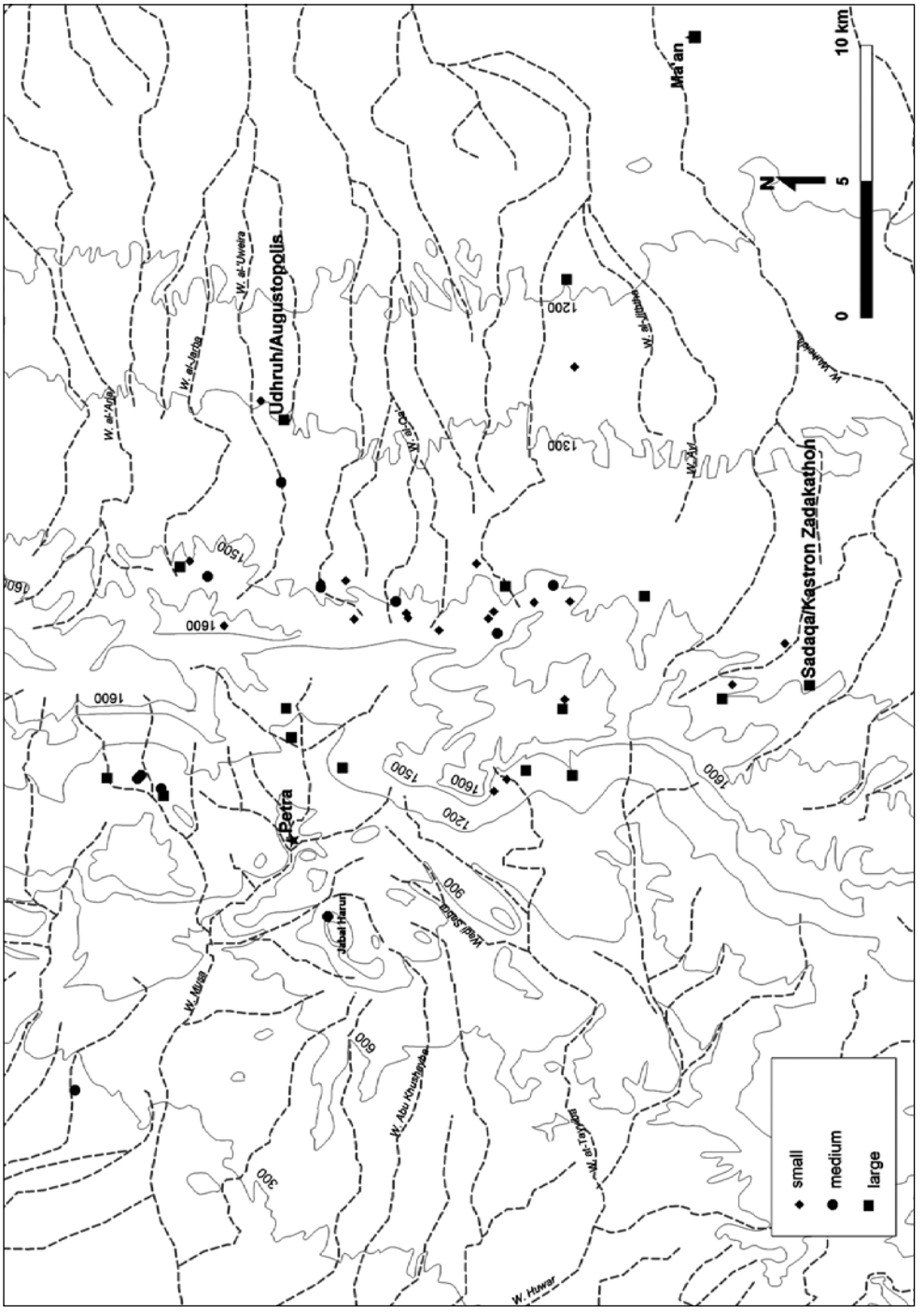
The process of the disappearance of small sites continues throughout the WMS area through the 4th and 5th centuries until no more than three of them remain in the 6th century (Fig. 4; Maps 22–23). The decline in the number of medium-sized settlements is not as abrupt as with the small sites, but, of the maximum of 13 medium-sized sites in existence during the 2nd century, only two remain by the beginning of the 6th century. A considerable decrease in sites has also been reported in the Jabal ash-Shara Survey (JSS) area after the 3rd century (Tholbecq 2001: 404–405). With the village-sized settlements, the situation is somewhat different. Although the number of large settlements also decreases by a total of three sites from the 2nd to the 4th century, the drop is nowhere near as steep as it is with small and medium-sized sites, and after the breaks in occupation in the 3rd and 4th centuries, large sites are resettled in the 5th and 6th centuries. The continuity of hamlets or villages into the Byzantine period was also attested in the Jabal ash-Shara survey (Tholbecq 2001: 405).

The settlement trend on the western periphery of the Petra region became different from that of the western Jabal ash-Shara area after the 4th century (Figs. 4, 6). The settlements that remained after the initial decrease of sites in the later 2nd century continued into the 4th, accompanied by the renewal of settlement at two medium sites after a possible break in the 3rd century. Then it seems that an almost complete withdrawal of permanent settlement took place on the fringes of Wadi 'Araba by the 5th century, including the abandonment of Qasr Umm Ratam (Maps 22–23). Even the large sites were abandoned: there is no evidence of continuity of settlement either at Sabra (Lindner and Zeitler 1997/98: 542–45) or at Abu Khushayba beyond the 4th century (Fiema 1991: 234). The fort at Bir Madhkur has yielded a few sherds of later pottery, but even there the main period of use for the fort is Late Roman–Early Byzantine (King *et al.* 1989: 205; Smith 2005: 58–59). Only one medium-sized settlement (FJHP Site 109) in the data set apparently remained occupied throughout the whole period under consideration (Table 2; Fig. 6). Since this site is on the northeast slopes of Jabal Harun, it can be suggested that the settlement was somehow connected to the occupation of the monastic complex, which was in use up until the 12th century (Fiema 2008a: 95).

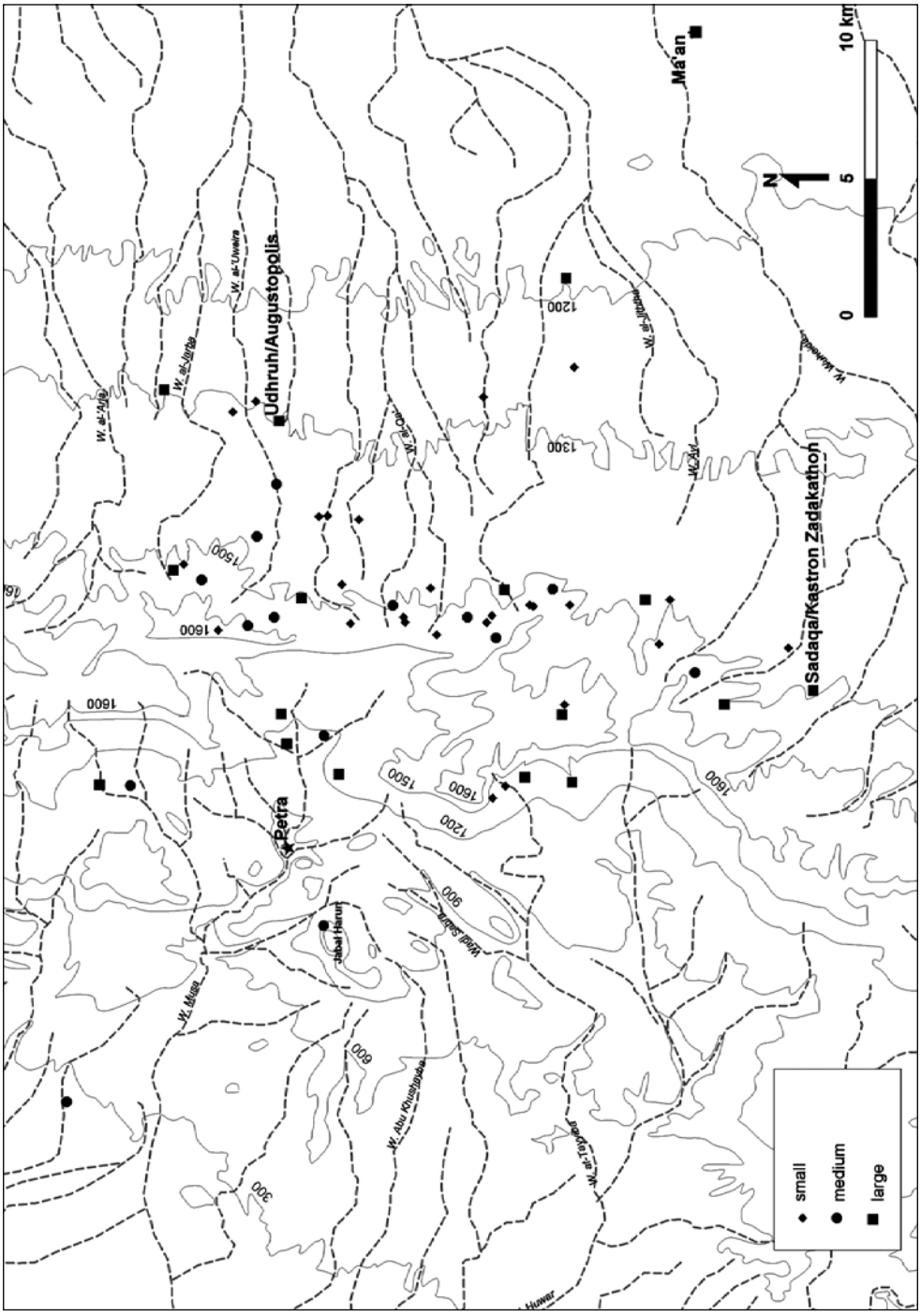
The eastern part of Jabal ash-Shara and the eastern periphery also show a somewhat different settlement trend (Fig. 5). After the severe reduction of sites by the 3rd century, the number of sites begins to slowly increase from the 4th century onwards. Several small sites were also abandoned in the 4th century, but at the same time, many formerly abandoned small and medium sites were resettled (Table 2). In addition to the continuity and expansion of previously settled sites, new village-sized settlements were established and old sites were resettled in the area during the Byzantine period (Killick 1983: 236–43; Killick 1986: 438), and Udhruh/Augustopolis evolved into a town (Fiema 2002b: 131). In the 6th century, there is also a remarkable increase in small and medium-sized sites, in complete opposition to the situation in the western part of the Jabal ash-Shara area (Map 24).



Map 22. The distribution of rural settlement in the 4th century AD.



Map 23. The distribution of rural settlement in the 5th century AD.



Map 24. The distribution of rural settlement in the 6th century AD.

If we look at the site continuity, it can be seen that single-period sites of any size are rare in the record (Table 2; Appendix I), which indicates a high level of continuity of site locations. Sites may have been abandoned and then reoccupied, but the number of entirely new sites is low after the initial establishment of rural settlement in the 1st century AD. The foremost reason for the persistence of settlement in the same locations is probably the limited availability of water in the region, although the presence of easily available building material and preexisting agricultural installations may also have influenced the choice of location when abandoned settlements were reoccupied.

Changes in the Early Islamic period

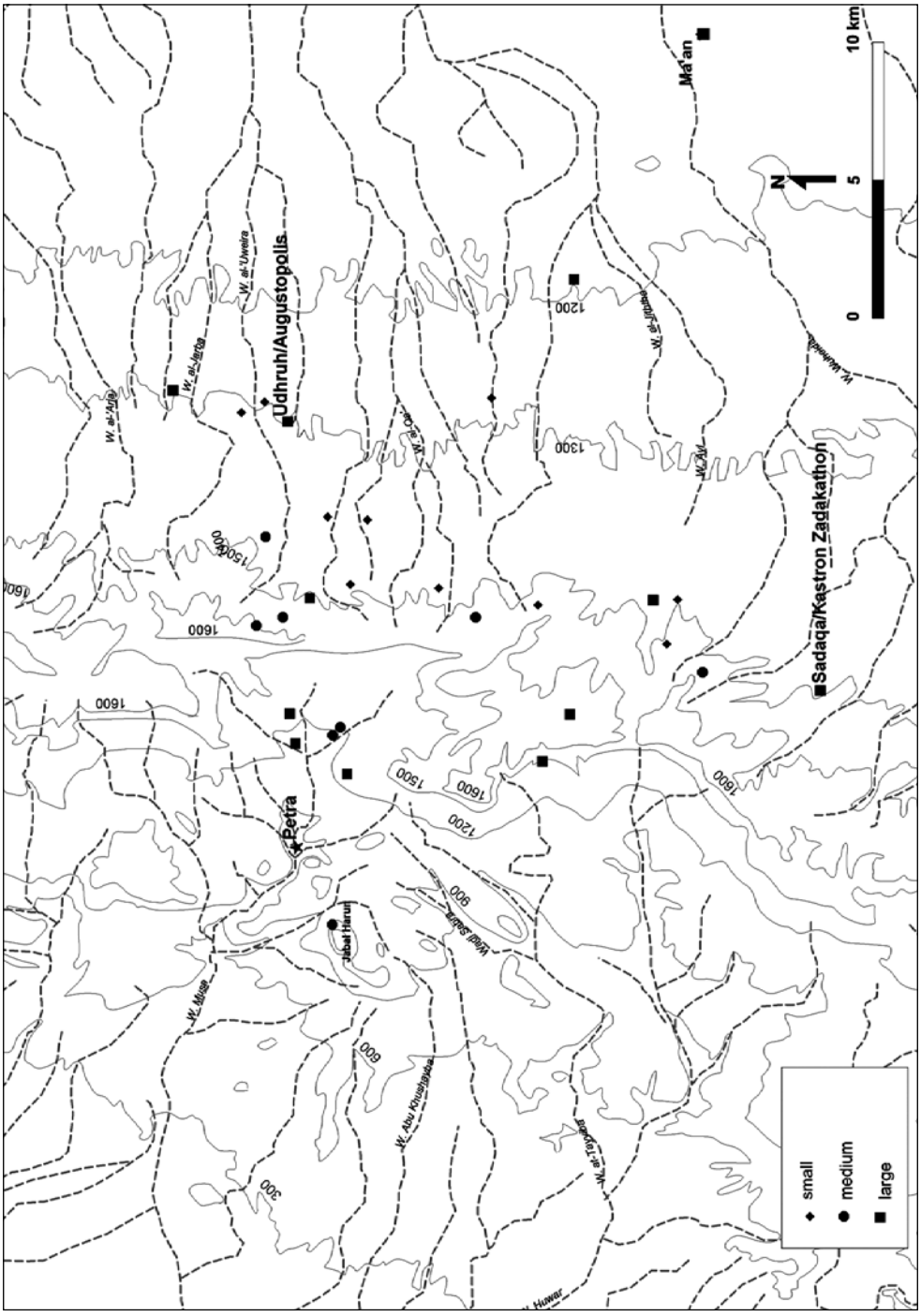
It seems that all the small and medium sites and even some of the large sites in the database for the WMS area were abandoned by the 7th century (Fig. 4; Map 25). Nor does the Late Byzantine expansion on the eastern part of the Jabal ash-Shara appear to be long-lived (Fig. 5). By the 7th century, a dramatic reduction of sites has taken place, with half of the medium and more than a half of the small sites being abandoned, and even the occupation at three of the large sites apparently being discontinued. However, the transitional forms of the 6th- and 7th-century pottery have so far been poorly known in the Petra region, and the picture may be somewhat biased. Moreover, the representation of the surface material of the later periods of occupation may be poor, and the continuity of settlement at the same locations makes the observation of archaeological evidence problematic.

Genequand (2003: 33–34) has suggested that during the Umayyad period three *qusur* (s. *qasr*) were established near modern Ma'an, one at al-Hammam[23] and two others, al-Mutrab and Khirbat as-Samra, further east, within the enclosed agricultural area along Wadi Ma'an, forming a single estate.[24] 'Amr has noted that most of the villages existing in the Petra area during the Late Byzantine period seem to continue to the Early Islamic period ('Amr *et al.* 2000: 241–43; 'Amr and al-Momani 2001: 267), and no immediate impact of the Islamic conquest (AD 630) can be observed in the archaeological record. Nevertheless, it seems that by the later 7th century, sedentary settlement had concentrated in fewer settlements, mainly large villages and towns, and the settlement in the Petra region had a distinctly eastern orientation.

A considerable decline in settlement seems to take place around the late Umayyad–early Abbasid period (Figs. 4–6). A gap in settlement starting from the 8th century is reported in the JSS area (Tholbecq 2001: 405) and in the Edom Survey (Hart and Falkner 1985: 258, 268). However, both Schick (1997: 81) and Walmsley (2001: 525) have pointed out that the apparent decline in permanent settlement for the Abbasid, Fatimid and Seljuq periods may partly be due to a bias of earlier archaeological research

[23] The archaeological remains of al-Hammam have been almost completely destroyed, but it has been identified as the possible location of the Byzantine Kastron Ammatha (see Genequand 2003: 25–26; cf. Findlater 2002: 141; Fiema 2002a: 212).

[24] Findlater (2002: 141–42) considers the agricultural complex to be of Late Byzantine date, and postulates a classical foundation for it.



Map 25. The distribution of rural settlement in the 7th century AD.

and the fact that the material culture of these periods is poorly known due to the lack of excavations. Recent archaeological research has brought forth the first evidence of settlement continuing through the Abbasid and Fatimid periods at the site of Khirbat an-Nawafla ('Amr *et al.* 2000: 243–44) and possibly also at Khirbat al-Mu'allaq ('Amr *et al.* 2002: 244; cf. Lindner *et al.* 1996a). Nevertheless, in the light of the present archaeological knowledge, settlement appears to cease after the Umayyad period at most known sites ('Amr *et al.* 1998; 'Amr and Al-Momani 2001: 267–68), possibly indicating an increase of the seminomadic population (Schick 1997: 82). The sedentary settlement seems to have concentrated further into the few towns and large villages. In the listings of early 10th-century Arab geographers, 'Adhruh (Udhruh) is mentioned alternately as the capital of the district of ash-Shara or al-Jibal (Schick 1997: 75). In the late 10th-century account of al-Maqdisi (al-Muqaddasi), 'Adhruh and Mu'an (Ma'an) are mentioned as townships in the ash-Shara region (Schick 1997: 75; Walmsley 2001: 517).

7.3 Site size and continuity as evidence of landownership and land use

In the following interpretation of the archaeological data, settlement size and continuity are considered as indicative of landownership and land-use practices following the model adapted from that of Alcock (1993), described in Chapter 2.3. The existence of newly established small settlements – single farmsteads – is considered as an indication of the intensification of land use and largely as evidence of private ownership and the cultivation of land by individual families. The reduction of the numbers of small and medium settlements, accompanied with the increase or expansion of large settlements, is taken as an indicator of settlement nucleation, which is interpreted as a sign of the concentration of landed properties into fewer hands. The discontinuity of rural settlement, reflected in the large numbers of abandoned sites, is interpreted as a sign of instability in the landholding system, such as might be caused by changes in the landownership introduced by, for example, the Roman annexation, or a move to a more mobile land-use strategy.

Hypothetically, the emergence of a landowning class could also be reflected in changes in land-use practices. Farming regimes are generally divided into intensive and extensive ones. They do not exclude each other, but can exist contemporaneously in the same region in different combinations depending on the environmental, technological, social and economic opportunities and constraints (Alcock *et al.* 1994: 144). Intensive, mixed cultivation is considered to be typical of small farmers, working close to the subsistence level (Garnsey 1999: 25). In an intensive farming regime, the fields are weeded, manured and irrigated if needed. In the archaeological record, intensive farming is often thought to be reflected in the distribution of pottery in the surroundings of settlements (Bintliff and Snodgrass 1988: 508). The pottery density decreases with distance from the settlement, reflecting a manuring pattern resulting from the practice of growing the plants that demand the most attention closest to the settlement (Snodgrass 1990: 124; Wilkinson 1988: 110–11; Alcock *et al.* 1994: 155–56).[25] The manure

[25] See also the critique of the 'manuring hypothesis' in Alcock *et al.* 1994: 166–68; and the reply by Snod-

with a high proportion of pottery sherds originates from settlements where household activities are carried out in close proximity to animals and the domestic refuse becomes mixed with the dung. This type of manuring practice is considered to be connected with intensive cultivation and generally smaller cultivated areas (Alcock 1993: 84).

Extensive agriculture, on the other hand, is typically associated with large landowners growing cash crops for markets (Garnsey 1999: 25–28). The distances between the settlement and fields are longer, and an extensive cultivation regime is characterized by different methods of management of agricultural land (Alcock 1993: 84). When associated with large estates, it involves large cultivated areas, but it is also common in societies where agriculture is a supplementary means of subsistence – for example, the somewhat opportunistic small-scale cultivation by the Bedouin in recent times can also be seen as a form of extensive agriculture. In the archaeological record, extensive cultivation is difficult to detect because it does not necessarily leave any material remains.

If we consider the size distribution of rural sites in the 1st–2nd centuries AD (Table 2 and Figs. 4–6), it can be seen that they form a three-tiered settlement hierarchy with small sites being the most numerous and each higher category being consecutively smaller in number. There are numerous small sites, but it is not possible to deduce from the archaeological remains whether these farmsteads were occupied by independent farmers or by tenants, and therefore the question of the division of landed properties in the Nabataean realm cannot be answered unequivocally. The building remains at isolated sites range from simple houses with one or two rooms, to multiroom mansions with courtyards (e.g., 'Amr *et al.* 1998: 538; 540). Without excavation, we cannot determine whether this could be the result of separate functions for these sites, but considering the evidence for social differentiation in Nabataean society from a wider perspective, we can suggest that the variability of small rural sites reflects actual differences in wealth.

If we turn to the data on settlement continuity presented above in Table 2, no immediate impact of the annexation can be seen. Most rural settlements established during the 1st century AD continue into the 2nd century. However, in the 3rd century the numbers of settlements decrease in all size categories. This development is seemingly more or less uniform throughout the Petra region, but it is more pronounced on the western and eastern peripheries. Whether this is a somewhat belated consequence of the annexation or a continuation of a preexisting developmental trend cannot be known, but the archaeological data indicating cultural continuity over the annexation suggests that the influence of the annexation should not be overemphasized.

The continuity of the large settlements in the WMS area is generally attested (Table 2). With the exception of one site, all the large settlements existing by the beginning of the 4th century appear to have continued from the 1st century. Seven of the eight large settlement sites that were in existence in the 6th century were inhabited since the 1st century AD. From a closer look at the WMS results, however, it can be seen that gaps of variable length occur in the occupation of several sites of all sizes, including some large settlements (Appendix I). These breaks vary in duration from a few decades to a couple of centuries. They take place particularly during the 3rd and 4th centuries,

grass 1994.

sometimes extending into the 5th ('Amr and al-Momani 2001: 239). During the Late Byzantine period, some of the preexisting settlements grew in size and probably also in population ('Amr and al-Momani 2001: 273). Tholbecq (2001: 404–405) also mentions that several substantial villages continued to exist in the Jabal ash-Shara area into the Late Byzantine period (see also Fiema 1991: 214–17). At the same time, small sites were mostly abandoned after the 4th century.

Breaks in the occupation of rural sites also occurred in the eastern part of the region in the 3rd century (Table 2). However, it seems that half of those medium and large sites that had been abandoned by the 3rd century were already resettled in the 4th century, and three of the previously medium-sized settlements grew into large ones (Appendix I). The numbers of small sites remain relatively constant from the 3rd to the 5th century, which together with the evidence for resettlement and growth of medium and large sites suggests an increase of the total of the settled population over this period. On the other hand, although the numbers of sites are not reduced, a discontinuity of small sites is also observable in the 3rd and 4th centuries (Table 2), which may signify the relocation of population within the eastern part of the region.

By the 5th century, the western periphery of the Petra region was nearly emptied of settlement. However, stability seems to have returned to the Jabal ash-Shara and the eastern parts of the region: most of the sites existing in the 5th century show evidence of continuity of occupation from the previous century. Large and medium sites on the western Jabal ash-Shara were resettled after the 3rd and 4th century. At the same time, the number of small and medium sites in the area declined, which could indicate settlement nucleation (Table 2).

The 6th century witnessed a further reduction of medium settlements in the western Jabal ash-Shara area, while some of the large settlements apparently grew in size. The eastern parts of the area, however, show a marked increase of rural activity: new small settlements are established and old ones are reoccupied. The numbers of medium and large settlements also increase in the eastern part of the Petra region. This increase in activity seems to be short-lived, however, since almost two thirds of the small settlements in existence in the 6th century are already abandoned in the 7th century (Table 2). The simultaneous drop in the numbers of medium and large settlements as well seems to indicate a wider abandonment of rural settlements, comparable to the 3rd century crisis.

Excursus: The question of mobile population

In southern Jordan, where the conditions for agriculture are marginal, the population has always drifted along a continuum of sedentary and mobile ways of life (see Finkelstein 1995: 26), with one or the other end of the spectrum sometimes dominating the picture the archaeological evidence provides for a certain period. The existence of a sedentary population in the Petra region always seems to be related to the presence of some kind of centralized authority on at least a regional scale, which in turn is related to economic and political ties to other regions. Permanent settlements characterize the

picture of these periods (e.g., Iron Age II, Nabataean, Roman-Byzantine), although in reality the sedentary population may have been a minority of the total population, or may have been settled for only a part of the year, like the premodern Petra Bedouin (Simms and Russell 1996: 7.3–7.7). The scholarly emphasis on the sedentary settlement is understandable, since the question of the presence of a mobile population is an archaeologically complicated one because of problems related to recognizing and dating ephemeral habitation sites.[26]

It seems likely that the sedentary settlement does not represent the whole of the Nabataean society, but a mobile element was retained among the population of the Petra region throughout the existence of the Nabataean kingdom, perhaps specializing in herding in the areas outside the permanent settlement and agricultural land, and/or practising a form of tethered mobility reminiscent of the historical Petra Bedouin. Temporary campsites have been found on the eastern desert margin (see 'Amr and al-Momani 2001: 278, 281). Some of the settlement sites may have been occupied only seasonally, but with no excavation data from rural sites, this is impossible to prove.

An increased nomadic pressure in the provinces of *Arabia* and *Palaestina* in the 3rd and 4th centuries has been cited as the reason for the fortification of the frontier (Parker 1986: 642–43). Graf has argued, however, that the literary evidence points to localized incidents rather than a threat of invasion by nomadic tribes (Graf 1997b: 344–51). The rather late date for the Byzantine fortification of Petra (probably in the late 4th century or later) as compared to other cities in Jordan seems to suggest the relative security of the region (Fiema 2002a: 221). In the easternmost part of the region, walled settlements existed during the Byzantine period, and in some cases, such as at Jabal at-Tahuna, the fields were also within the walls (Killick 1986: 438). On the other hand, the fact that there were extensive unwalled settlements established to the north of Udhruh/Augustopolis, for example at Jarba (Killick 1986: 438), points towards the unlikelihood of an external threat. Fiema (2002b: 135) has concluded that there does not appear to have been a marked external threat in southern Jordan during the Byzantine period before the Persian invasion and occupation in the early 7th century (614–629).

While the older conception of the relationships between settled agricultural populations and pastoral nomads, 'the desert and the sown,' was one of hostility (e.g., Awad 1962: 335–36; Spooner 1972: 126–30), more recent models have emphasized the mutually beneficial relations between agriculturalists and herders (Bates 1971; Gellner 1973: 2–3) and the need for the presence of a settled agricultural population for specialized herding to be feasible (Khazanov 1994: 202–205; cf. Cribb 1991: 25–27). For example, in the Negev, a close relationship between herders and townspeople is thought to have existed in the Byzantine period, the seminomadic herders providing the towns with meat but being also dependent on the permanent settlements for their subsistence

[26] There are two opposing views concerning the archaeological remains left by nomadic people. Finkelstein (1995: 23–30) has stressed that at the extreme nomadic end of the settled–nomadic continuum, the archaeological remains are missing, while others have maintained that archaeological remains will always be present and recognizing them is a question of methodology (see, e.g., Cribb 1991: 66–83; Banning and Köhler-Rollefson 1992).

(Haiman 1995: 31–34). A similar system may well have been in operation in the Petra region, but the current archaeological data is insufficient to prove it.

In the Petra Papyri, herding is mentioned only once and then indirectly, in connection with the sale of property that also includes grazing rights (P. Petra III: 36, 134 Comm.; Gagos and Frösén 1998: 477). A large, multiperiod campsite where pottery from the Nabataean-Roman to the Byzantine periods was found, was studied by the WMS in the Jiththa sector ('Amr and al-Momani 2001: 281), which suggests that relationships existed between the mobile and settled populations in the Petra region.

To what degree the fluctuation in the numbers of rural sites in the hinterland of Petra after the original establishment of sedentary Nabataean settlement is due to the fluctuation of population in the settled-mobile spectrum is another moot question. Nevertheless, when settlement changes in a region such as the Petra area are considered, it should be borne in mind that the number of permanent settlements does not necessarily reflect the whole population and that the movement of the people along the settled-mobile continuum is likely to be a factor in changes in the archaeologically observable pattern of sedentary settlement. There are a number of possible explanations for this phenomenon, but one reason, which has often been cited for the reversion of the population back to a more mobile way of life in the Petra region, is environmental change brought about by climatic change and/or human overexploitation. This will be considered in more detail in the next chapter.

CHAPTER 8. – ENVIRONMENTAL EXPLANATION REVISITED

It has often been suggested that environmental change, either climatically forced or caused by human activities, is a significant factor behind the archaeologically observable changes in settlement in the Petra region. One explanation that has been offered is the potential onset of catastrophic erosion, triggered by human overexploitation of the Jabal ash-Shara area for cultivation and herding (Fiema 2006: 82; Besançon 2010: 34). This suggestion is based on the fact that while the entire region is environmentally vulnerable to erosion and land degradation, under the current climatic conditions, the most vulnerable area is that of Jabal ash-Shara.[27] However, it should be noted that erosion is dependent on many factors, such as the timing and intensity of rainfall on one hand, and land-use practices, which affect the vegetation cover, on the other. A regional study of human-induced environmental change such as severe erosion would therefore require large-scale sedimentary studies, which have not been done for the Petra region so far.

As long as there are no good coverage studies on erosion in the Petra region, it is impossible to estimate the impact and role of human land-use practices on environmental degradation, and its counterinfluence on settlement and land use. However, it is possible to compare the distribution of settlement sites, discussed in the previous chapter, with the relatively well-established climatic history for the Classical and post-Classical periods, to explore whether the settlement changes can be related to climatic change.

As already illustrated in Chapter 5, the variable lithology, topography and elevation of the Petra region, combined with the semiarid climate and mainly orographic rainfall, create a situation of relatively narrow environmental zones at different elevations, which is reflected in both natural vegetation and the conditions for agriculture and human settlement until the introduction of modern water management and irrigation technologies. Because the climatic and other environmental controls have remained the same from the period covered by this research until the present day,

[27] Research has shown that there is the most erosion in Mediterranean-type shrublands with steep topography when the annual rainfall is 200-300 mm. Where the rainfall is lower, its erosive power is also less significant, and with a higher annual rainfall, there is more vegetation to bind the soil (Bull & Kirkby 2001: 7; Beven 2001: 67).

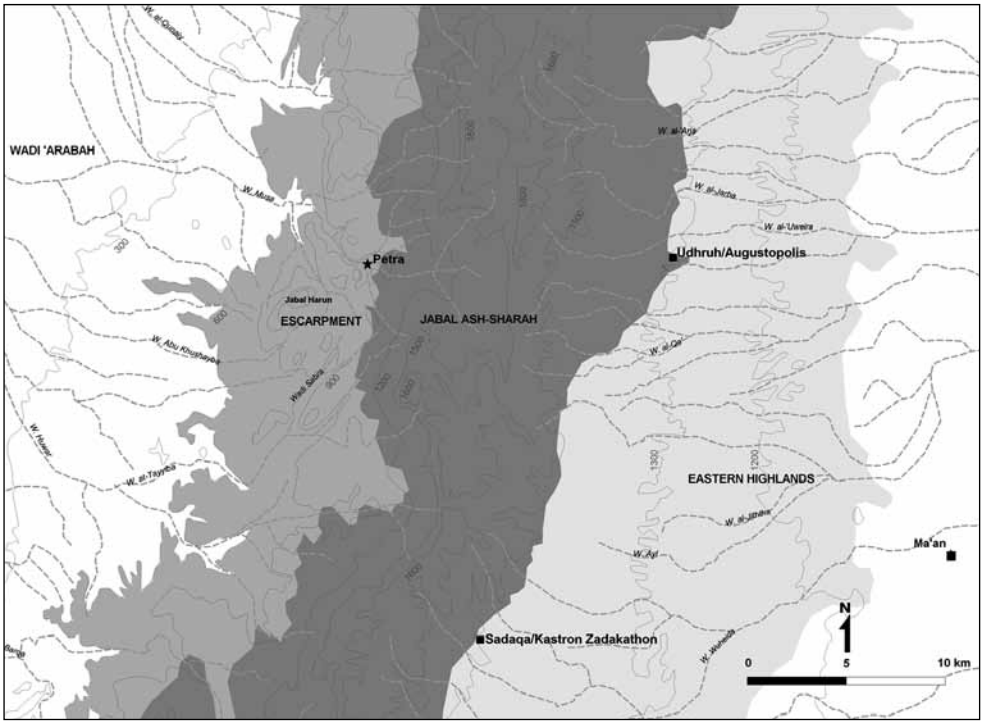
it can be postulated, based on what is known about the characteristics of rainfall in southern Jordan, that climatic shifts towards increased aridity led to more frequent occurrences of drought and an increased likelihood of crop failure. Regardless of the overall climatic trend, Jabal ash-Shara can be considered in any given period to have the highest and most reliable rainfall, the most numerous perennial springs and the best agricultural soils in the Petra region. On the other hand, the fact that rainfall becomes spatially and temporally more variable with increasing distance from Jabal ash-Shara indicates that fluctuations of climate are more pronounced on the eastern and western peripheries of the region, which, as a result, are more vulnerable to drought during periods of increased climatic aridity. Therefore, it can be postulated that periods of adverse climatic conditions should be reflected as contraction or even withdrawal of permanent settlement and agriculture from the environmentally marginal western and eastern peripheries of the region.

8.1 Agro-ecological zones

In FAO agro-ecological zoning, zones are defined for evaluating the potential for the production of different crops and the land management systems needed. The zoning is based on combinations of soil, landforms and climatic characteristics (FAO 1996). In the following, I have attempted a rough zoning for the Petra region. Since soil formation is controlled by lithology, topography and amount of rainfall, I have used the 1:250,000 Soil Map for the Petra region (Royal Jordanian Geographic Centre 1995) as a base map for the division. However, I combined the soil areas of western and eastern Jabal ash-Shara, treating the whole area as one agro-ecological zone, which also covers the Bayda area and the surroundings of Udhruh. I also limited the Wadi 'Araba Escarpment Zone to the elevations above 600 m asl on topographical as well as lithological grounds. My division is by necessity a simplified one since it does not recognize small-scale variation in lithology, soils and topography, but it can be considered to adequately reflect the broad environmental conditions in the different parts of the Petra region (Map 26).

The Wadi 'Araba Zone

The Wadi 'Araba Zone is characterized by the lowest rainfall and highest temperatures year-round, resulting in high evaporation and low effective moisture availability. At present, there are irrigated orchards in the Wadi 'Araba. In ancient times, floodwater cultivation was possible in the alluvial areas of wadis. There is archaeological evidence of hydraulic structures and field walls and even relatively extensive cultivated areas in the lower Wadi Musa and around Bir Madhkur (Smith 2005; 2010: 75-79) and Qasr Umm Ratam (Lindner *et al.* 2007) during the Nabataean-Early Roman period. In these plots, at least cereals and pulses could have been grown. However, the known archaeological evidence for agriculture does not extend far into this zone. The saline soils of



Map 26. The agro-ecological zones for the Petra region.

the Wadi 'Araba form a problem for agriculture because, under irrigation, there is a high risk of increasing salinity, which results in the soils becoming hypersaline and no longer suitable for cultivation.

The Escarpment Zone

The mean annual rainfall of this zone, which is around 150 mm in Petra (Lane and Bousquet 1994: 22) and decreases towards the western edge of the zone, is barely sufficient for the dry farming of barley, and the soils are mostly shallow and poor in nutrients, which suggests that the cultivation of more demanding plants would require manuring and that without manuring, the soils are vulnerable to nutrient exhaustion. At present, the area is used for sporadic dry cultivation of barley and lentils, and there are the occasional irrigated gardens in the wadis, for example, in Wadi as-Sabra and Wadi as-Siyyagh, which utilize the water present in the wadi bed. The expanses of bare, steep sandstone slopes generate high run-off, which enables the effective collection of rainwater and run-off cultivation (Bruins 1986: 39–43; Yair and Kossovsky 2002: 55). Extensive run-off farming systems can be found, for example, in the Jabal Harun area (Lavento *et al.* 2004). Nabataean cisterns, many of them still in use, can be found adjacent to the areas of arable land.



Figure 7. Fields on Jabal ash-Shara, to the north of Petra. (Photo: P. Kouki.)

The Jabal ash-Shara Zone

The best conditions for agriculture in the Petra region are in the Jabal ash-Shara area because only there the mean annual rainfall, ca. 200 mm, is high enough to support the dry cultivation of cereals (cf. Besancon 2010: 42). The higher elevations and resulting lower temperatures also contribute to less evaporation and more available moisture than elsewhere in the region. On the other hand, especially at the highest elevations, the low winter temperatures may be a limiting factor for agriculture, and the steep slopes are vulnerable to erosion while under cultivation. The springs that occur at the border of the permeable limestones and underlying nonpermeable sandstones provide water for human and animal consumption as well as for irrigating the more demanding cultivated plants such as olive, vines and fruit trees. The western slopes are so steep that they require terracing to prevent erosion, and evidence of ancient cultivation terraces and run-off control systems is abundant everywhere in the western part of the area (e.g., Tholbecq 2001: 403–404). In the central and eastern Jabal ash-Shara area, the slopes are relatively gentle, and there the fields are separated by strips of land not cleared of stones rather than actual terracing (Figs. 7–8).

The Eastern Highland Zone

The highland zone beyond the Jabal ash-Shara is in the rainshadow area, which means that the mean annual rainfall drops towards the east, being only 43 mm at Ma'an (Me-

teorological Department of the Hashemite Kingdom of Jordan 2004). The soils of the area are of poor agricultural quality. The temperatures are higher than in the Jabal ash-Shara area, but the diurnal variation in temperature is great, and the winters are colder than in the western zones of Wadi 'Araba and the Escarpment. The rainfall at present is too erratic for dry cultivation, although barley can be cultivated in the alluvium of the wadis in most years (Jordan Soils & Land Management 2006). However, the utilization of run-off farming can increase the availability of rainwater. There is evidence of run-off cultivation systems and large reservoirs in the region between Udhruh and Ma'an. Furthermore, a *qanat* system has been discovered near Udhruh and another possible *qanat* system has been recorded to the west of Jabal at-Tahuna. The reservoirs are associated with predominantly Late Byzantine–Early Islamic pottery, but it is uncertain whether the *qanat* system near Udhruh is of similar date (Abudanh 2007: 486–90, 492–95).

8.2 Archaeological evidence for agricultural practices

Run-off cultivation

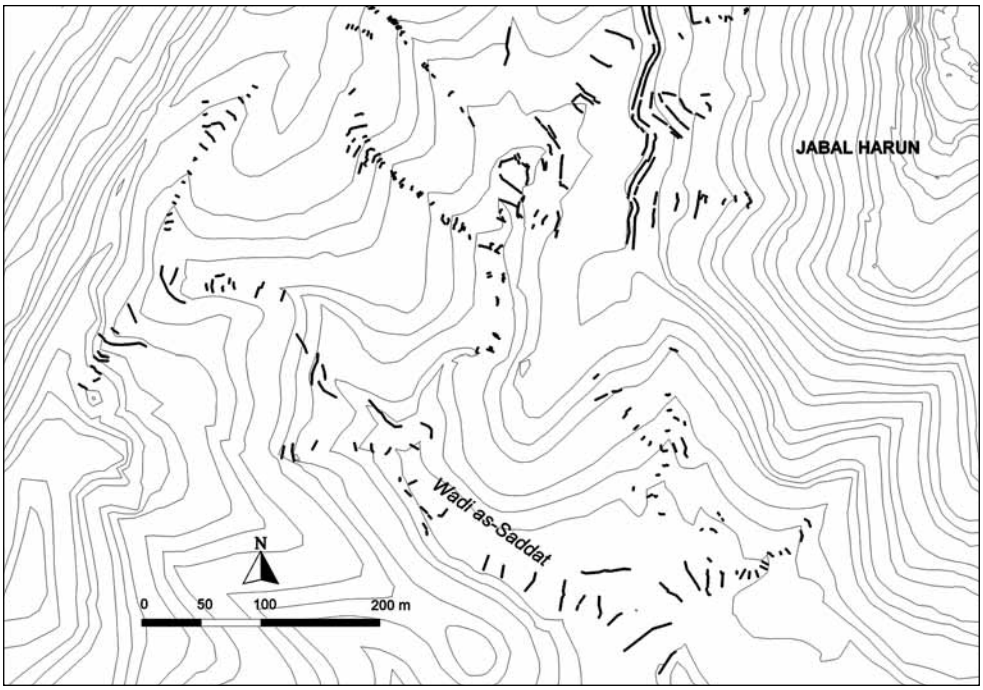
The most prolific archaeological remains related to ancient agriculture in the Petra region are structures related to run-off farming. This cultivation method is based on building a system of dams in the wadis and terrace walls on hillsides to collect rain-



Figure 8. Terraced fruit and olive gardens in Wadi Musa, around the traditional village and ancient site of Khirbat an-Nawafla. (Photo: P. Kouki.)

water and direct it into the small field plots on the lower slopes and in wadi bottoms (Mayerson 1962: 231–49). As noted in other studies of run-off and floodwater farming (Gilbertson and Hunt 1996: 192; Mayerson 1962: 232; Bruins 1986: 36–38), the dating of the systems is complicated, because often there is no datable material associated with them, and similar structures have been constructed in recent times. The closest parallels for the run-off farming systems of the Petra region are those that have been studied in Wadi Faynan (Newson *et al.* 2007) and in the Negev (Mayerson 1962; Evenari *et al.* 1971: 95–119, Bruins 1986). Remarkably similar systems dating from the Roman period onward have also been studied in Libya (Gilbertson and Hunt 1996), testifying to how widespread run-off cultivation was in antiquity in arid and semiarid regions.

Although it has been suggested that some run-off cultivation structures may be of Iron Age date (Lindner *et al.* 1996:150), a Nabataean origin has been suggested for many of the run-off cultivation systems in the Petra region ('Amr *et al.* 1998: 512–17, 532–33; Tholbecq 2001: 404; Findlater 2002: 141–43), mainly based on the dating of the adjacent settlement sites and/or pottery found on the fields themselves. In the area surrounding Udhruh/Augustopolis, some field systems were probably established during the Byzantine period (Killick 1986: 438). Although the run-off farming systems in the Negev were originally dated to the Nabataean period, later research has indicated that many of them have actually been established in the Byzantine period or even later (Mayerson 1962: 232; Bruins 1986: 36–37). Likewise, in Wadi Faynan the cultivation



Map 27. Part of the functionally integrated run-off farming system west of Jabal Harun, documented by the FJHP survey. The thick black lines indicate barrages and terrace walls. (FJHP/Institute of Photogrammetry and Remote Sensing, Aalto University /P. Kouki.)



Figure 9. Structures related to run-off cultivation in the Jabal Harun area, west of the mountain. (Photo: FJHP/P. Kouki.)

systems were revealed to be multiperiod, extending from the Bronze Age to the Byzantine period (Newson *et al.* 2007: 169–74). This, together with the fact that the Bedouin have practised run-off cultivation and slope terracing in the Petra area as recently as in the 20th century (Russell 1995: 696; Lavento *et al.* 2004: 166), suggests that care should be applied before unequivocally attributing all the run-off farming structures in the Petra region to the Nabataeans.

The FJHP survey has documented numerous run-off harvesting structures to the west of Jabal Harun, about four kilometres southwest of Petra (see Map 27 and Fig. 9). The field survey results have revealed that the main body of the pottery dates between ca. AD 20 and the early 2nd century (Lavento *et al.* 2004: 166–67). The dating of the pottery has been taken to indicate the original date of construction and use of the run-off farming system and to be related to intensive agricultural practices, namely manuring. The existence of contemporary rural settlements in the area supports the hypothesis (Lavento *et al.* 2007b: 148). The high level of functional integration between the structures in different tributary wadis has led to the suggestion that the run-off cultivation system may initially have been part of a single estate, such as royal or temple property (Frösén *et al.* 1998: 498–99). It could be reasonably expected that the existent field system was also used by the monastic establishment on top of Jabal Harun from the late 5th century AD onward, but there is practically no off-site pottery dating to this period. As an explanation, a change in the cultivation mode from intensive to extensive in the Late Roman–Byzantine period, probably associated with a change to less-demanding crops, can be suggested (Lavento *et al.* 2007b: 151).

The Jabal Harun area is marginal for agriculture, and no far-reaching conclusions about changes in land-use practices can be made concerning the whole Petra region from the evidence presented above. Unfortunately, there is little information available on off-site artefact spreads elsewhere in the region, as they have not been systematically recorded in other surveys. However, in several cases documented by the WMS ('Amr *et al.* 1998: 506, 515–17; 'Amr and al-Momani 2001: 256), the presence of Nabataean pottery on the fields adjacent to run-off farming structures has been mentioned, while

the occurrence of Byzantine pottery is rarer ('Amr *et al.* 1998: 516–17, 532). In the light of the nucleated settlement pattern, it could be expected that a shift to more extensive land-use practices took place during the Late Roman–Byzantine periods.

Cisterns and irrigation

There are several springs on the western slopes of Jabal ash-Shara which have attracted both settlement and agriculture. Due to the drop of the water level since ancient times, some of these springs have dried up or surfaced at lower elevations, but the extensive systems of ceramic water pipes and associated cisterns in the area give evidence that water from the springs was transported both to the settlements in the modern Wadi Musa area and down to Petra. In many cases, the installations appear to be originally Nabataean, but they have been reused later (see, e.g., 'Amr and al-Momani 2001:259, 267, 270). Water channels and reservoirs have also been found in the eastern parts of Jabal ash-Shara, transporting water from springs to settlements further away (Abudanh 2007: 485–86).

Cisterns for floodwater or run-off collection can be found practically everywhere in the region. They range from simple natural cavities, which have been walled off and enhanced with hydraulic plaster to hold water, and quite often also roofed to reduce evaporation and keep the water clean, to underground structures carved into the bedrock, with elaborate arrangements of conduit channels and settling tanks. Some of the cisterns are apparently for storing water for domestic use because they are located close to building remains, but others are within agricultural fields and could be conceivably used for small-scale irrigation. They could also provide water for herd animals. However, not all cisterns are originally meant for storing water for mundane consumption: water played an important role in Nabataean religious rituals, and cisterns and associated run-off collection installations can be found at cultic sites. The ancient Nabataean cisterns and water channels have often been reused in later periods and many of them are still used by the locals (e.g., 'Amr *et al.* 2000: 234; 'Amr *et al.* 2000:239).

Archaeological evidence for cultivated plants

Grains form a dietary staple, and it is likely that they were cultivated in the Petra region throughout the period under consideration. Although wheat was probably more valued (Braun 1995: 33–34), barley has also been cultivated for human consumption, as indicated by the barley grains present in Late Roman contexts from the excavations of ez-Zantur (Karg 1996: 358, the table) and in Late Byzantine–Early Islamic contexts in the monastery on Jabal Harun (Tenhunen 2001: 386–87). Barley is more tolerant to drought and extreme temperatures than wheat which means it can be more reliably cultivated in agriculturally marginal areas (Braun 1995: 25–26).

The direct archaeological evidence for grain cultivation is limited to a number of threshing floors that have been found, for example, in the Jabal Harun area (e.g., FJHP

Sites 13, 29) and in Abudanh's survey of the Udhruh region (Abudanh 2006: 203). The most simple threshing floors are simply areas of bedrock cleared of stones, while others are at least partially walled and occasionally also paved with flagstones. The age of these installations is as difficult to determine as that of the run-off cultivation structures. It is known from ethnographic sources that some of them were used by the Bedouin in the 19th–20th centuries. However, threshing floors may also have been reused (Simms and Russell 1996: Table 7.1 p. 8). Sometimes threshing floors are located close to ancient building remains, which suggests they might be contemporaneous with those (Abudanh 2006: 203; FJHP Site 128).

It is likely that various pulses, such as lentils and broad beans, chickpeas and lupin, have been an important part of the diet (Dar 1995: 330), and they have also been cultivated for local consumption. Lentils and other unidentified legumes have been found in archaeobotanical samples from both ez-Zantur (Karg 1996: 358, the table) and Jabal Harun (Tenhunen 2001: 386–87), spanning the Late Roman and Byzantine through Early Islamic periods, respectively.

Other crops would have included fruit and vegetables, which could have been grown in irrigated gardens under shade-providing trees like at present in the Wadi Musa area. No archaeobotanical evidence for vegetables has been preserved, because their seeds are small, soft and easily destroyed. Archaeobotanical remains from ez-Zantur provide evidence of the cultivation of fig trees and possibly also date palms in the Late Roman period (Karg 1996: 358, the table; Jacquat and Martinoli 1999: 29).[28] The apparent success of Nabataean viticulture in the Bayda area suggests that also other relatively demanding crops, such as fruit trees, could have been grown with the aid of run-off farming.

Olives have been one of the most important cash crops in antiquity. The remains of several olive presses have been found in the Khirbat an-Nawafla area in Wadi Musa. The oldest of these has been dated to the 1st century AD (Nabataean-Early Roman period). The other presses date to the Early and Middle Islamic periods and the early 20th century (Amr *et al.* 2000: 233–34). Another Nabataean press has been found at al-Bad in Wadi Musa, and a Late Byzantine–Early Islamic olive press was found at Khirbat Dhba' in at-Tayyiba ('Amr and al-Momani 2001: 265, 273). These structures were probably reused and rebuilt on the site because the pressing stones were expensive and difficult to transport ('Amr *et al.* 2000: 234).

Pollen of olive trees *(Olea sp.)* was found in the analyses of fossil Hyrax middens for both the Nabataean-Roman and Byzantine periods (Fall 1990: 227). A great amount of crushed olive stones were found in a Late Roman context in ez-Zantur, most likely representing pressing waste used as fuel (Karg 1996: 357). Olive stones are also present in the archaeobotanical samples from Jabal Harun, although they probably represent foodstuffs brought to the monastery rather than indicate that olives were grown in the immediate vicinity (Tenhunen 2001: 386–87). It seems likely that the main area for olive cultivation in antiquity consisted of the western slopes of Jabal ash-Shara, such as the valley of Wadi Musa (see al-Salameen 2004: 153), where water necessary for the

[28] However, dates could be imported to Petra from the Dead Sea region. The existence of date groves there during the Nabataean-Roman period has been attested in the Babatha papyri (Papyri Yadin 2 and 3).

establishment of the gardens was abundant. However, it is likely that the olive oil produced was intended for local use and not for trade as such (al-Salameen 2004: 198). In the Nabataean-Roman period, the oil was used not only for consumption as food, but also as a component in the manufacture of perfumed oils (see Johnson 1987: 36–40).

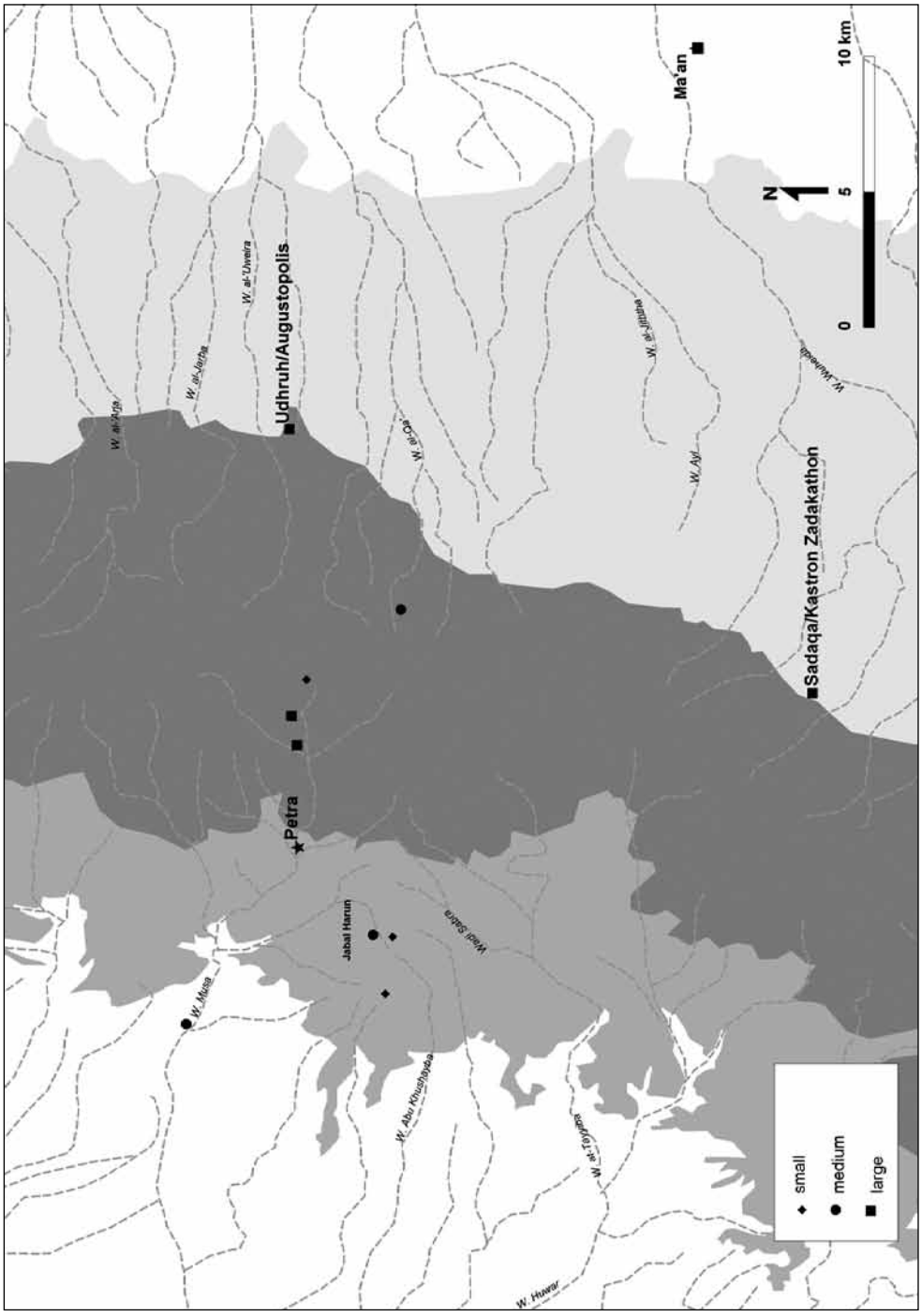
As compared to olive production, there are many more archaeological remains of viticulture *(Vinus vitifera)*. Numerous wine presses have been found in Nabataean contexts, particularly in the Bayda area. They represent primitive types with trampling vats (al-Salameen 2004: 159–60). There is no evidence of the Greek screw press introduced throughout the Roman world from the 1st century AD onward, and attested, for example, in Byzantine Palestine (Patrich 1995: 483). However, these installations could have also been used in later periods (al-Salameen 2004: 159–60, 167, 190–91). At least two of the sites where winepresses have been found yield evidence of continued use through the 4th–5th centuries ('Amr *et al.* 1998: 506–11). The archaeobotanical samples from ez-Zantur, dated between AD 150–400, have yielded grape pips, which, similarly to the olive stones, appear to be pressing waste used as fuel (Jacquat and Martinoli 1999: 25, 29). Like olive oil, wine is considered to have been produced for local consumption (al-Salameen 2004: 195).

It has also been argued that the Nabataeans may have cultivated a number of aromatic or resinous plants, which were used as raw materials for the unguent and perfume industry in the 1st–3rd centuries AD. These would have included rock rose (*Cistaceae* family), sweet rush/ginger grass *(Cymbopogon schoenus)*, *Balanites aegyptica* and the terebinth tree *(Pistacia terebinthus)*. With the exception of sweet rush, which is only found in marshy environments, these plants grow naturally in the Petra area at present (Johnson 1987: 36–47). The evidence for their cultivation is, however, mainly circumstantial.

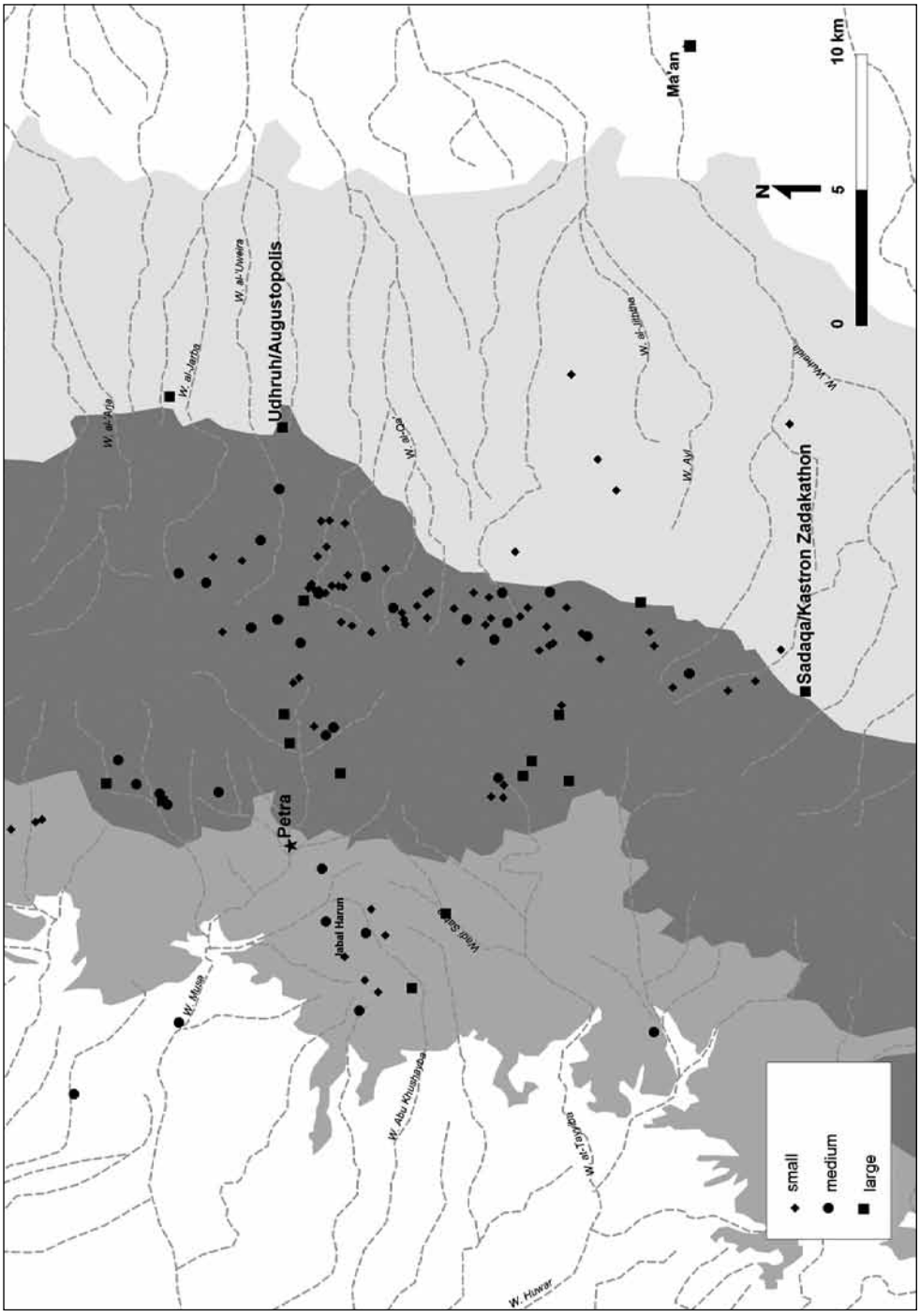
8.3 Environment, climate and human settlement history

From Map 28, it can be seen that the first rural sites were established in the Jabal ash-Shara and Escarpment Zones with few exceptions, but in the 1st–2nd centuries AD, rural settlement spread into all agro-ecological zones (Maps 29–30). Although the Wadi 'Araba Zone appears less intensively settled, run-off cultivation has also reportedly taken place in the vicinity of Umm Ratam and around Bir Madhkur, suggesting that settlement and agriculture was more common in the Wadi 'Araba than is apparent from the present maps. However, the sites in the Wadi 'Araba Zone are smaller, being mostly single farmsteads or hamlets, and agriculture was apparently limited to the wadis and their immediate surroundings. In the Eastern Highland Zone, there is only a scatter of small settlements. The intensification of rural settlement mostly takes place in the Jabal ash-Shara and Escarpment Zones.

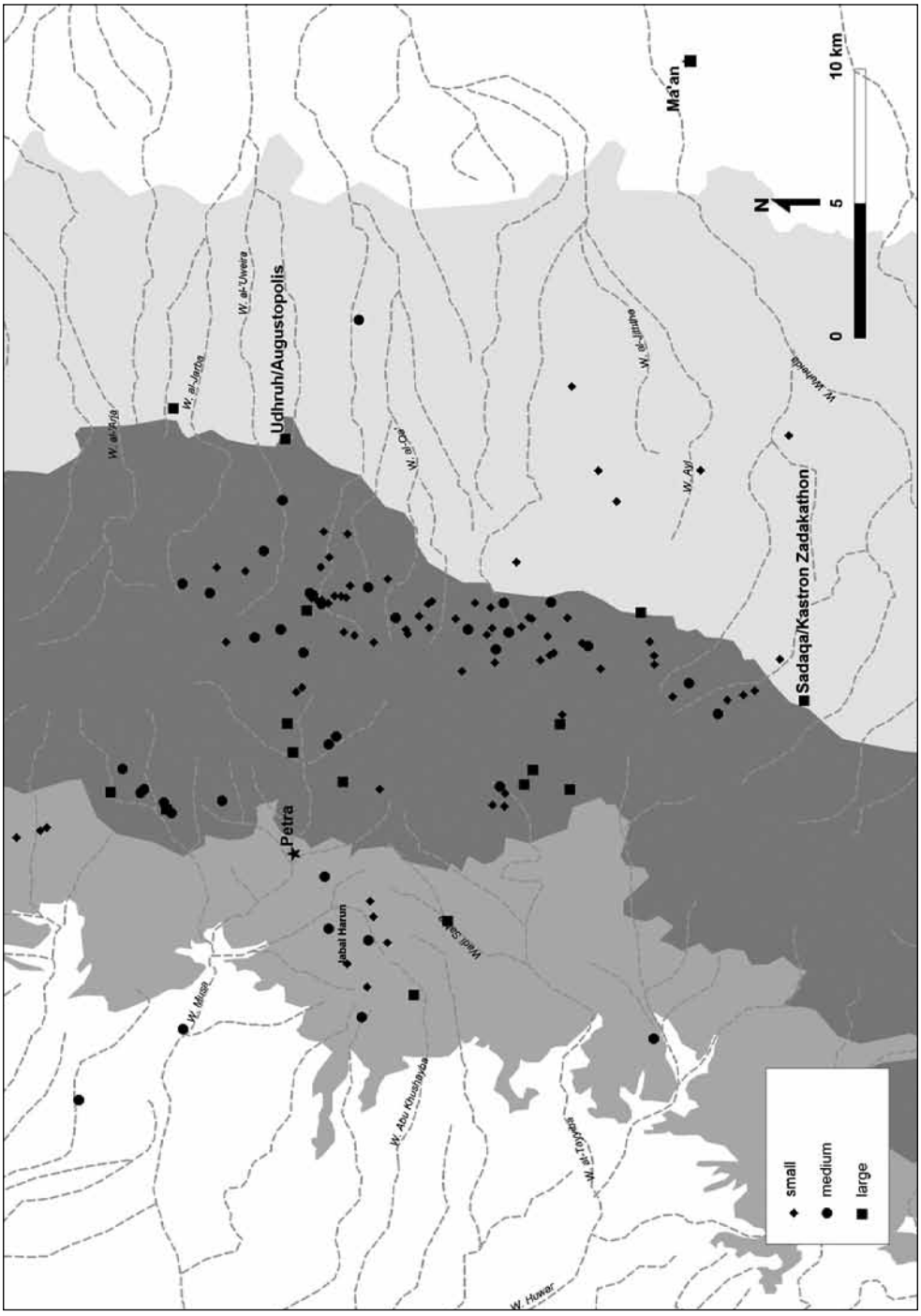
The widespread reduction of rural settlements in the 3rd century took place throughout all environmental zones (Map 31). Particularly small and medium-sized settlements were abandoned, but there are also breaks in the occupation at several large sites (Appendix I). Most of the small sites in the Escarpment Zone have disappeared, and the occupation of the small agricultural sites in the Bir Madhkur area in the Wadi



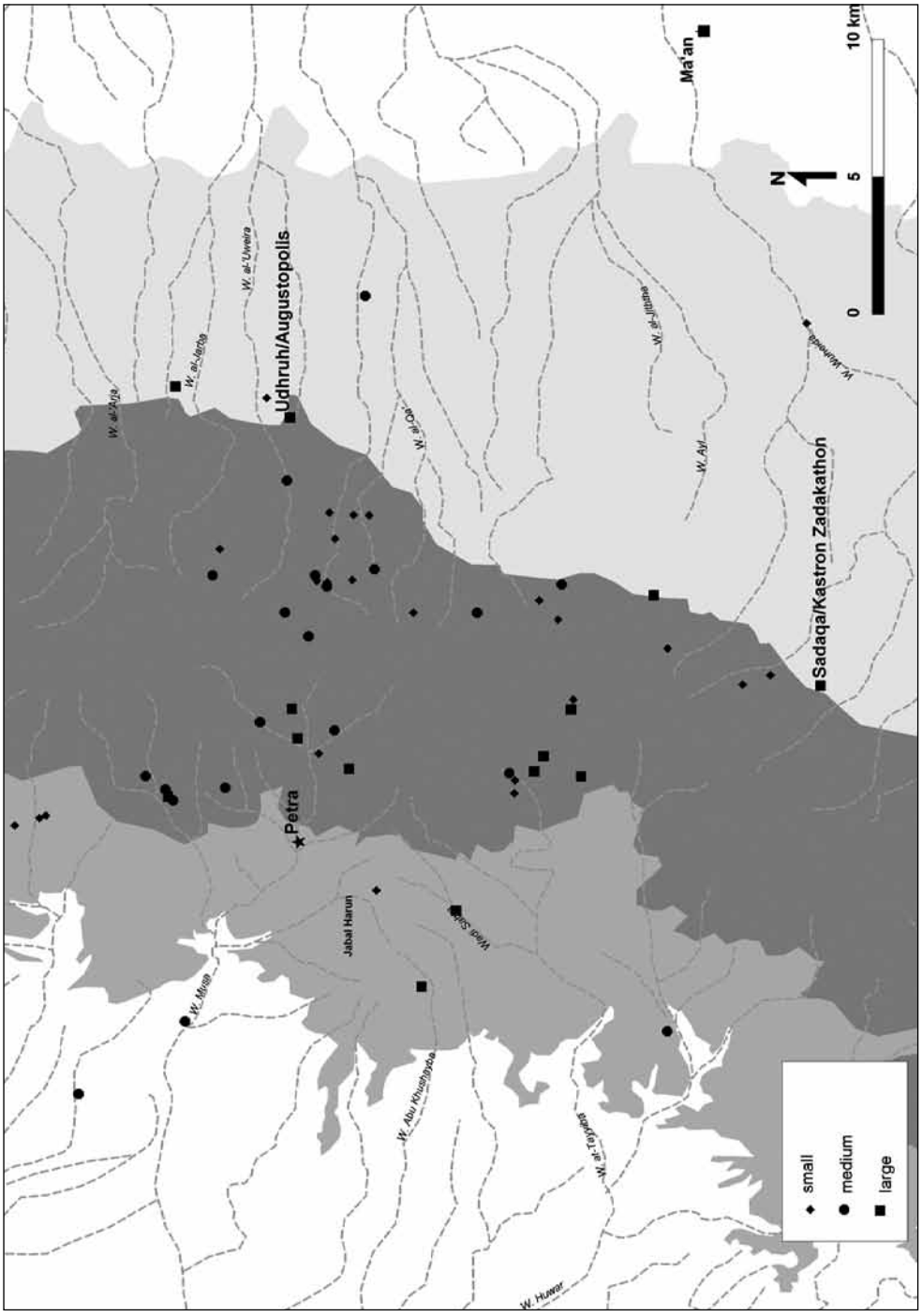
Map 28. The distribution of rural settlement across the agro-ecological zones in the 1st century BC.



Map 29. The distribution of rural settlement across the agro-ecological zones in the 1st century AD.



Map 30. The distribution of rural settlement across the agro-ecological zones in the 2nd century AD.



Map 31. The distribution of rural settlement across the agro-ecological zones in the 3rd century AD.

'Araba Zone does not extend to the Byzantine period (Smith 2005: 63–71). It can also be seen that permanent settlement almost completely withdrew from the Eastern Highland Zone.

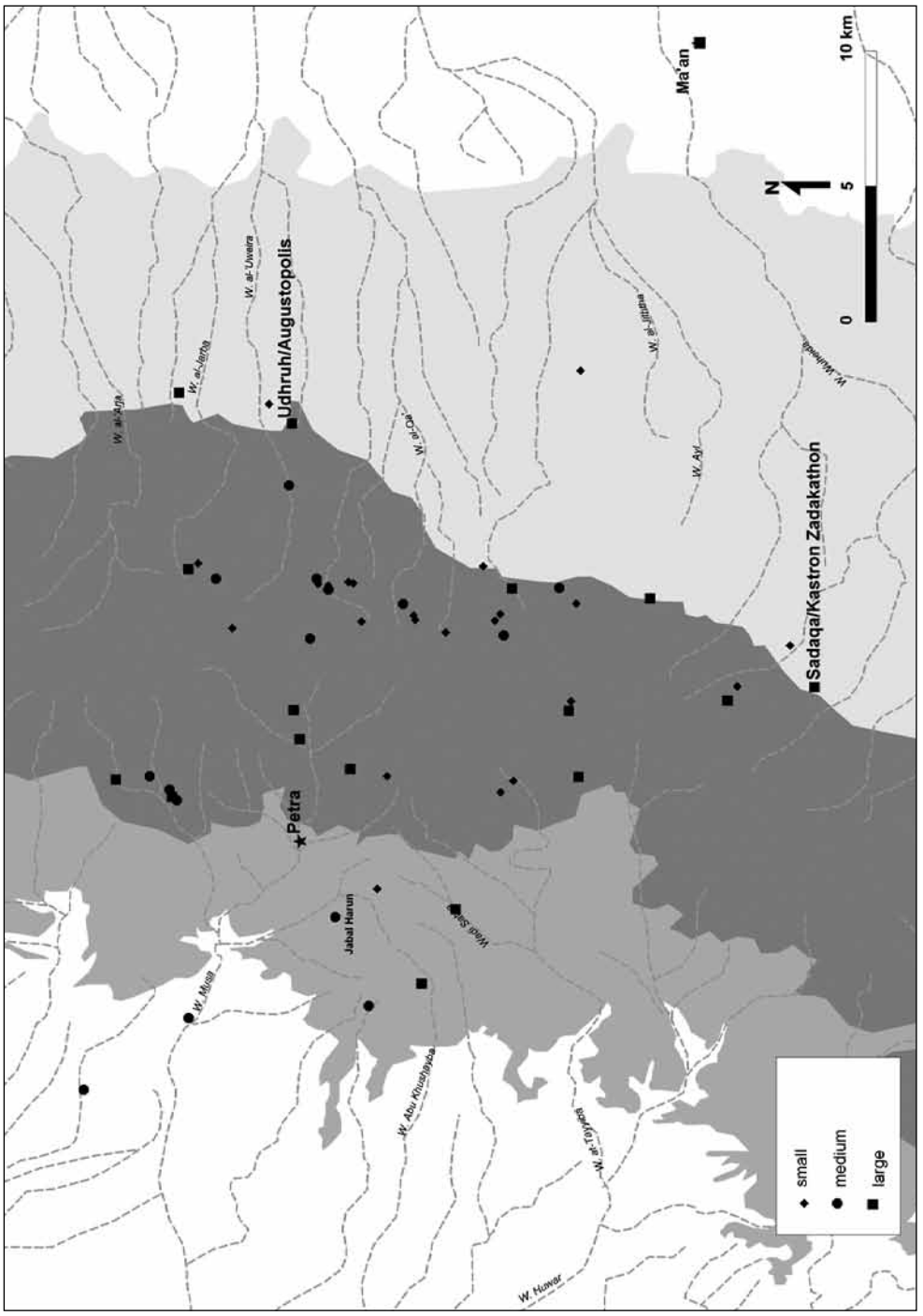
A drop in the number of small and medium sites continued in the Jabal ash-Shara Zone through the 4th and 5th centuries (Maps 32–33). In the Escarpment and Wadi 'Araba Zones, the reduction of sites was even more dramatic. By the 5th century an almost complete withdrawal of settlement from the western extremity of the Escarpment Zone and an emptying out of the Wadi 'Araba Zone has taken place. It can be seen that the Eastern Highland Zone remained relatively empty of settlement. However, in the 5th century, the large agricultural settlement of Jabal at-Tahuna was established on the eastern margin of the Eastern Highland Zone (Map 33).

The 6th century (Map 34) witnessed a renewed expansion of agricultural settlement in the eastern part of the Jabal ash-Shara Zone, with the reestablishment of small and medium sites and the growth of existing sites (see Appendix I). In the western part of Jabal ash-Shara, rural settlement is dominated by large villages, which remain relatively constant from the previous century. A considerable reduction of rural settlement took place in the Bayda area, where it had remained constant since the 4th century. Some further expansion of settlement seems to take place in the Eastern Highland Zone, with the resettlement and intensification of land use at Jarba and the postulated Late Byzantine agricultural settlement in the Ma'an area.

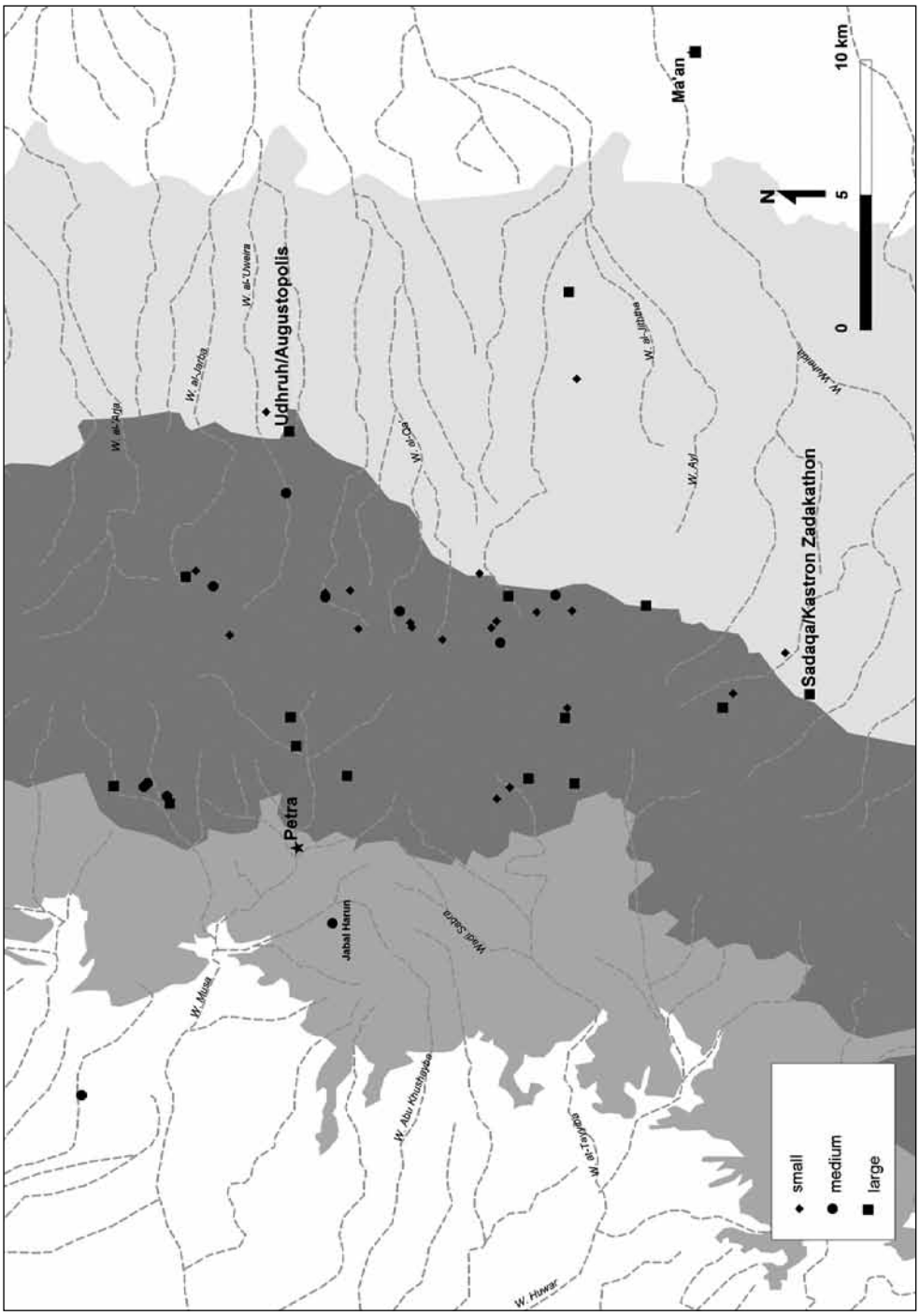
In the 7th century (Map 35), a considerable reduction of settlement apparently took place, with the concentration of settlement into a few large and medium sites. In the western parts of the Jabal ash-Shara Zone, the settlement seems to have concentrated in the modern Wadi Musa and at-Tayyiba areas. In the eastern part of the Jabal ash-Shara Zone, most of the small settlements established in the previous century were abandoned. However, the large agricultural settlements in the Eastern Highland Zone show continuity well into the 7th century.

From the above, it can be seen that during the entire period under consideration, rural settlement has been the most intensive in the Jabal ash-Shara Zone, as could be expected on the grounds of that zone being the most favourable for agriculture in the Petra region. However, the highest elevations above 1600 m seem to have been largely devoid of agricultural settlement (cf. Tholbecq 2001: 403). In the Wadi 'Araba Zone and the Escarpment Zone, agricultural settlements seem to have largely disappeared after the 3rd century. The rural settlement in the Eastern Highland Zone has been sparse for most of the period of study, with the exception of the 5th–6th centuries, when large agricultural sites were established at Jarba and Jabal at-Tahuna and possibly also in the Ma'an area.

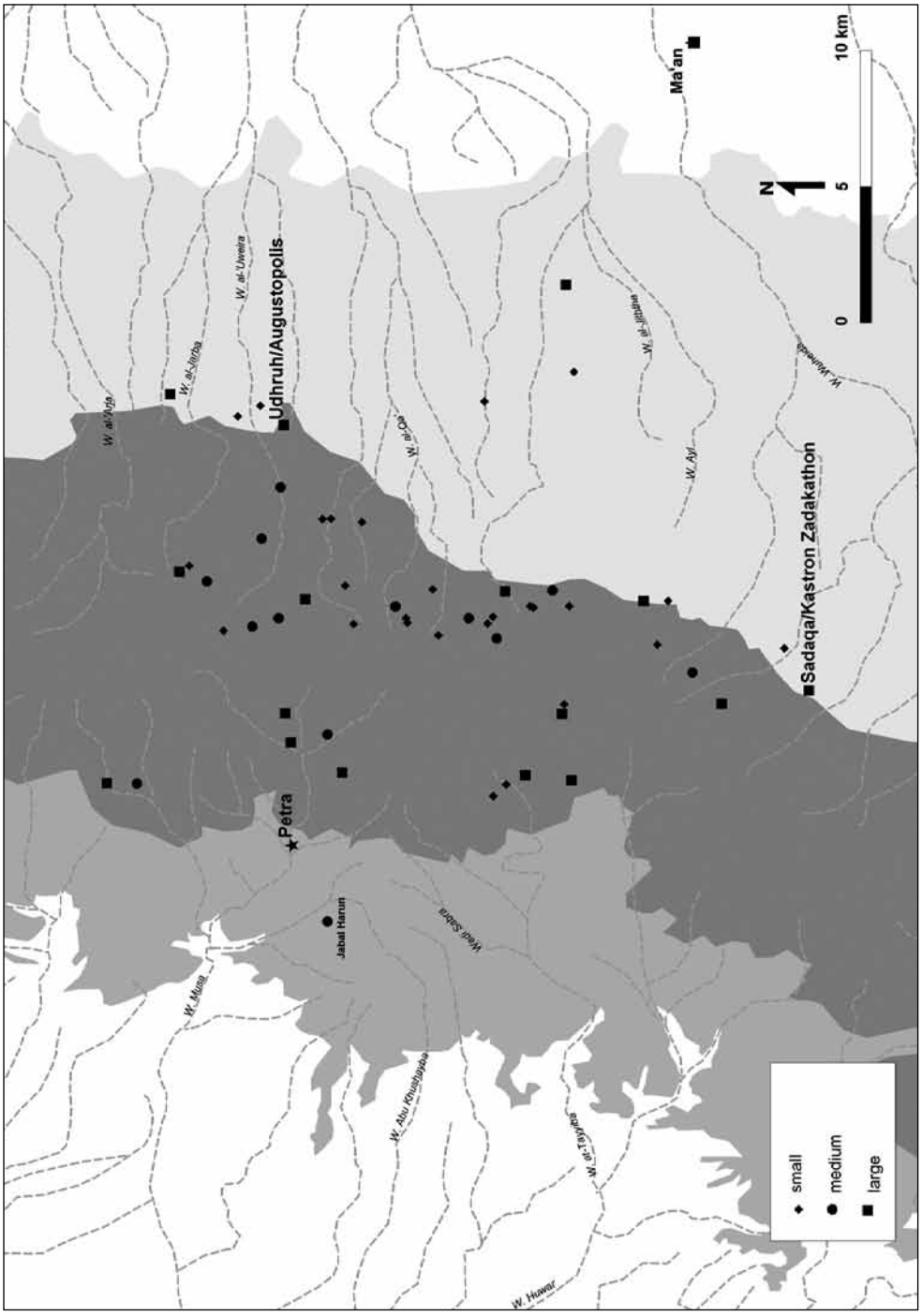
The palaeoclimatic evidence for relevant periods in southern Jordan, which was discussed above in Chapter 5.2, is presented in Table 3 together with the settlement trends. It can be seen from the table that the rapid intensification of Nabataean agricultural activity and rural settlement between the 1st century BC and the 1st century AD took place during a more humid climatic phase starting in the 3rd–2nd century BC. The increased rainfall and the potentially lessened evaporation due to a cooler climatic phase provided good conditions for the intensification of agricultural production.



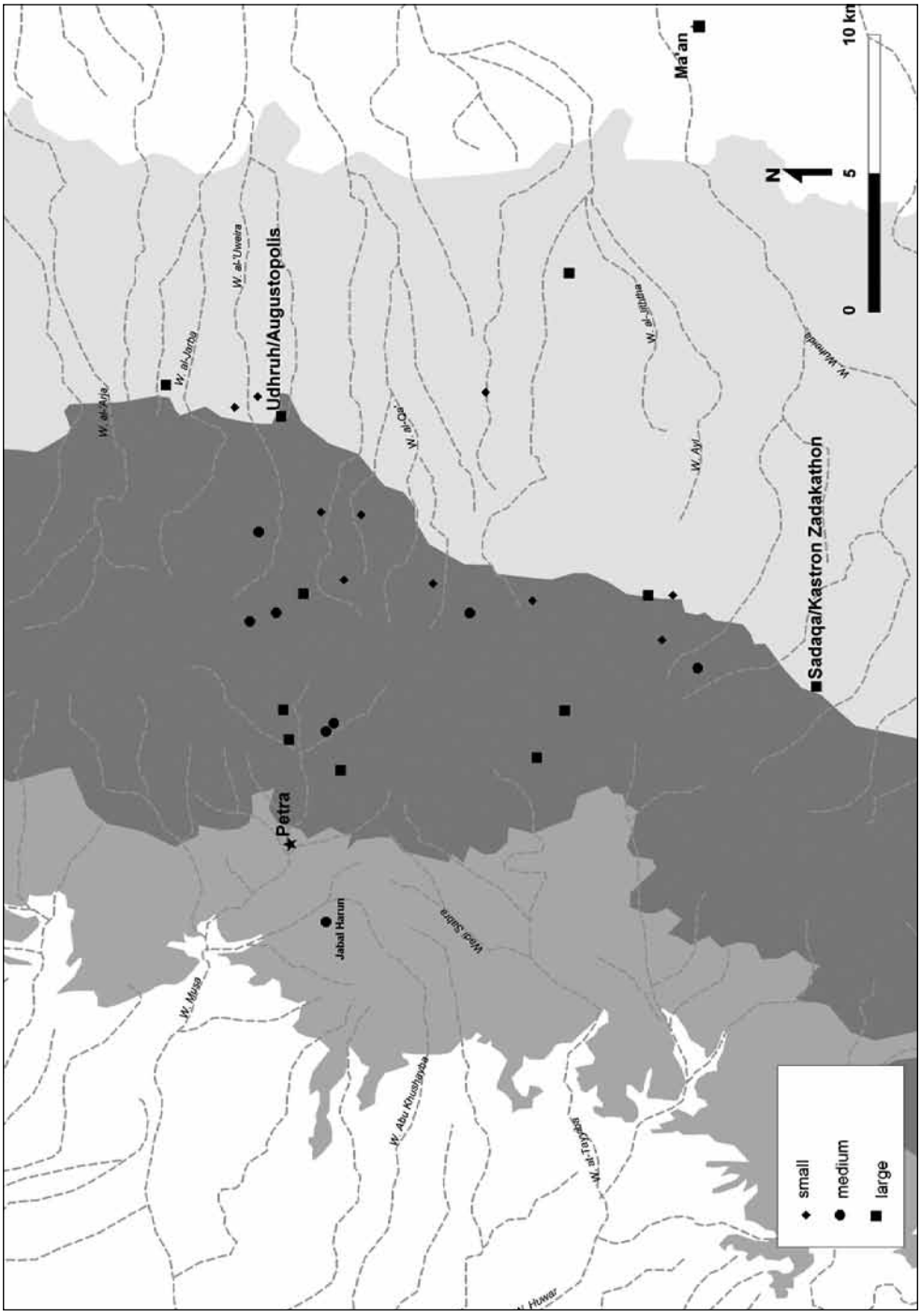
Map 32. The distribution of rural settlement across the agro-ecological zones in the 4th century AD.



Map 33. The distribution of rural settlement across the agro-ecological zones in the 5th century AD.



Map 34. The distribution of rural settlement across the agro-ecological zones in the 6th century AD.



Map 35. The distribution of rural settlement across the agro-ecological zones in the 7th century AD.

Table 3. A reconstruction of the climatic history and rural settlement in the Petra region.

TIME	CLIMATE	SETTLEMENT IN PETRA REGION
AD 800	climate very arid	concentration of rural settlement into a few large sites
AD 700		end of Petra as a city?
AD 600	gradually increasing aridity through the 6th and 7th centuries	abandonment of many rural sites in the late 6th–7th centuries
AD 500	aridification of climate starts in the 5th century	increase of rural settlement in the Eastern Highlands during the 6th century
AD 400	possible drop in rainfall around AD 400	first agricultural sites established on the eastern margin of the Eastern Highlands in the 5th century
AD 300		discontinuity of settlement, drop in the number of rural sites
AD 200	a return to more humid conditions in the 3rd century	widespread abandonment of rural settlements by the early 3rd century
AD 100	a possible drop in rainfall around AD 100	
0	the humid climatic phase culminates around the turn of the era	proliferation of rural settlement and intensification of land use in the 1st–2nd centuries
100 BC	climate more humid than at present	first rural settlements elsewhere in the Petra region
200 BC		first rural settlements in the Jabal ash-Shara area
300 BC	climate becomes more humid, possible cooling	settlement at Petra
before	an arid climatic phase	no permanent settlement

However, the intensification of sedentary rural settlement lagged behind the beginning of this humid period by a couple of centuries. The humid climatic phase culminated around the late 1st century BC, but the main expansion of rural settlement occurred only in the 1st century AD.

If there already was a drop in rainfall in the beginning of the 2nd century AD, it does not seem to have had an immediate impact on rural settlement. However, although the relative humidity apparently increased again in the late 2nd–3rd centuries, a significant abandonment of rural settlement took place in all agro-ecological zones over the same period. By the 4th century, most agricultural settlements had withdrawn from both the western and the eastern peripheries of the region, and rural settlement had largely become concentrated in the Jabal ash-Shara Zone, where the number of large settlements increased. The palaeoclimatic data concerning the 4th century is somewhat ambiguous, but the climate seems to still have been relatively humid. Therefore, climate does not seem to have played a significant role in the abandonment and relocation of rural settlement, which took place in the late 2nd–4th century AD.

The palaeoclimatic data point towards increasing aridity from the later 5th–6th century onwards. The 5th and 6th centuries witnessed a reduction of rural settlements in the western Jabal ash-Shara Zone, accompanied by an expansion of settlement and agriculture into the Eastern Highland zone, especially in the 6th century. Since the Jabal ash-Shara Zone receives the most reliable precipitation in the Petra region, it does not seem plausible that the increased aridity would be behind the drop in site numbers there, especially while it is combined with the simultaneous expansion of settlement in the Eastern Highland Zone and even towards the environmentally marginal desert fringe, areas that receive considerably less precipitation. On the other hand, the presence of run-off cultivation systems in the Eastern Highland Zone suggests that the characteristics and the amount of rainfall must have been suitable for run-off farming. The results from agricultural experiments in the Negev indicate that the mean annual rainfall of ca. 100 mm can be transformed to ca. 300–500 mm of effective precipitation by the intensive collection of run-off (Evenari *et al.* 1971: 109; see also Bruins 1986: 38–44). Thus, even a 50-mm annual rainfall could have been multiplied to 200 mm, enough for grain cultivation, particularly if the rainfall occurred in heavy storms, which generate a lot of run-off. A strengthening of the Red Sea Trough, which would have brought increased numbers of rainstorms to southern Jordan, can be hypothesized, but in the light of the present palaeoclimatic data, it cannot be proven. However, even so, precipitation in the eastern desert margin would have been localized, irregular and unpredictable, with great annual variation in the spatial distribution and amount of rainfall. Therefore, other explanations than favourable climatic conditions should be sought for the agricultural expansion towards the east in the later Byzantine period.

CHAPTER 9. – LANDOWNERSHIP AND LAND USE IN ANCIENT WRITTEN SOURCES

9.1 The Nabataean-Roman Period

The 4th-century BC account of Hieronymus of Cardia, as cited by Diodorus (19.94.2–9), states that the Nabataeans were nomadic camel and sheep herders and traders. Although the information on prohibitions on buildings and agriculture can be considered unreliable, the lack of archaeological evidence for permanent settlements in the areas where the Nabataeans are mentioned in the historical sources in the 4th–3rd centuries BC supports the presumption that they mainly followed a mobile lifestyle. It seems probable that the Nabataeans originally practised agriculture alongside herding much in the same manner as the Bedouin did in historical times (Simms and Russell 1996: 7.3–7.5; Levy 1992: 68–69). Among the Bedouin of Petra, each extended family or kin group had the commonly recognized, ancestrally determined right to pasture and to cultivate in certain areas.[29] From such an ethnographic analogy, it can be suggested that during the period when the Nabataeans were still mainly herders and traders, they followed a similar system. Ethnographic parallels suggest that along with sedentarization, such ancestrally determined rights of use may have been transformed into ownership (see examples in Khazanov 1994: 199; see also Friedman and Rowlands 1982: 235–36). The first sedentary rural settlements, which appear in the surroundings of Petra in the 2nd–1st centuries BC, could be indicative of this process.

The intensification of cultivation, with its associated expansion of rural settlement in the 1st–early 2nd centuries AD, was formerly attributed to an agricultural endeavour instigated by Rabbel II as a response to the economic crisis, which resulted from the presumed decline of the long-distance trade through Petra as early as in the 1st century AD (Negev 1977: 639–40). The reexamination of previous hypotheses (Fiema 2003) and the archaeological evidence that supports the continuation of long-distance trade into the 3rd century indicate that a more likely scenario is that offered by Fiema (1991:

[29] Based on the information from a local Bedouin, Salim Qublan of the B'dul tribe. The B'dul families still consider certain areas in the vicinity of Petra to belong to them. Variable systems of allocation of pasture land to different groups within the community are common among mobile societies (e.g., Swidler 1973: 24–25).

75; 2003: 41): the expansion of cultivation and rural settlement was related to the need to produce surplus for the growing section of the non-food producing population in the increasingly complex Nabataean society.

According to the description by Strabo, writing in the last decades BC, the residents of Petra owned luxurious houses and cultivated fruits in irrigated orchards (Strabo 16.4.26). Strabo's account is generally accepted to date from a period when the Nabataeans were already sedentary or in the process of becoming so. However, there is little firsthand information about land tenure in Nabataea. Rare historical evidence for landownership in the Nabataean realm comes from the so-called 'Papyrus Starcky' (Starcky 1954; P. Yadin 36; Yardeni 2001: 128–137) and the Babatha archive (Papyri Yadin).

The earliest of these documents is the fragmentary papyrus already found in the Dead Sea region in the 1950s and first published by Starcky (1954). Although the provenance of the document is obscure, it was probably originally found in the same caves where the Babatha archive was later recovered (see Yardeni 2001: 121–22). Recently, Ada Yardeni (2001) has provided a new arrangement and translation for the document. The document, dated between AD 58 and 67 during the reign of Malichus II (AD 40–70), concerns a complicated legal matter concerning the inheritance of mortgaged property, including a palm grove with its irrigation rights, and other properties. The document also contains a reference to an earlier document, which contained the original writ of seizure of the mortgaged property in AD 43 (Yardeni 2001: 126–27). Among the six Nabataean legal documents of the Babatha archive, there are two deeds of sale of a palm grove owned by a Nabataean (Papyri Yadin 2 and 3; Yadin *et al.* 2002: 201–44; Yadin 1962: 238–41), possibly the very same grove as in P. Yadin 36. These documents date to AD 97/98, that is, the latter part of the reign of Rabbel II (AD 70/71–106).[30]

From these documents, it can be deduced that in the Nabataean realm, at least around the mid-1st century AD, and probably well before that land was considered private property, which could be inherited, mortgaged, bought and sold. Although the properties mentioned in the Nabataean documents of Papyri Yadin are located in the area south of the Dead Sea, the area belonged to the administration of Petra (Bowersock 1996: 76–78), and there is no reason to suppose that the situation in the Petra region would have been markedly different.

There is no evidence in the literary sources for the total size of the Nabataean landholdings or the distribution of landed property within the society. Strabo describes the Nabataeans as a relatively egalitarian people, at least from a Roman point of view, but he also mentions that they honoured highly those who managed to amass wealth (Strabo 16.4.26). It seems plausible that the stratification of Nabataean society was already well underway at the time when Strabo wrote his description (see Schmid 2001: 374). Certainly wealth was ostentatiously visible in the 1st century AD, in the elaborate, monumental tombs (Schmid 2001: 384–89) and in the luxurious 'Nabataean villas',

[30] Hannah Cotton (1997) has discussed whether the land mentioned in the papyri should be considered private property or land on lease from the Nabataean king. In the final publication of the documents, the interpretation of the land as private property is preferred (Yadin *et al.* 2002: 228–29).

which have been excavated both in Petra (Kolb 2001) and in its suburbs ('Amr and al-Momani 2001: 266–67; 'Amr *et al.* 1997).

It is unclear how much disruption in the landholding system was caused by Rome's annexation of the Nabataean kingdom in AD 106. Proof for some level of disruption in the landholding system related to the annexation may be seen in the Babatha archive. The Jewish family owning the archive seems to have retained their properties, but the personal names of those who owned the neighbouring lands indicate that while the landowners had been Nabataeans before the annexation, after it there were more Jews in the area (Bowersock 1991: 340).

The documents of the Babatha archive also indicate there were landed properties of the Nabataean royal house in the Dead Sea area that became imperial estates after the annexation (Cotton 1997: 257; Graf 2001b: 479). It has been suggested that there were Nabataean royal properties in the Petra region (Graf 2001b: 479). In fact, Findlater (2002: 143–44) has proposed that there is archaeological evidence for a broad, managed landscape straddling the *Via Nova Traiana* east of Dana and to the north of the region considered here. He suggests that the arrangement of the farmsteads, cultivation systems and defensive sites in the area points towards the existence of a Roman to Byzantine imperial estate, which could be identified with an earlier Nabataean royal estate.

9.2 The Byzantine Period

The Petra Papyri provide proof that landholdings were inheritable, passed down within families during the 6th century, and this may have already been the situation for a long period of time before the papyri were written, as the apparently oldest scroll in the archive, Papyrus Petra 17 (unpublished) concerns a division of a considerable property among three brothers (Gagos and Frösén 1998: 473). This suggests that the presence of a wealthy landowning class in Petra extends back to the 5th century and probably much earlier than that.

With respect to the archaeological evidence for widespread abandonment of rural settlements by the 6th century, only a couple of deserted hamlets are mentioned in the Petra papyri (Gagos and Frösén 1998: 475; Arjava *et al.* 2007: 33–40, 67–73; P. Petra III:19, 3–4 Comm.; P. Petra III:23, 8–9 Comm.). This matter can be linked to the nature of the archive. Abandoned settlements as such would not have held much interest for the landowners. Interestingly, the deserted hamlet in Papyrus Petra 19 is mentioned as a part of the description of vineyards under cultivation; likewise, Papyrus Petra 23 seems to describe the location of agricultural land. This suggests that although the settlement was abandoned, the vineyards and fields continued to be cultivated. As not only the owners but also the farmers of these fields obviously lived somewhere else, this can be taken as indirect evidence of settlement nucleation.

It is impossible to determine how much of the total arable land in the Petra region was actually in the hands of the large landowners, both private and institutional (such as the church and the imperial house). Most of the potentially identifiable toponyms in

the Petra papyri are located in the Jabal ash-Shara area (Daniel 2001), but on the other hand, there is information that the residents of Petra also owned land that was under the jurisdiction of Augustopolis and was therefore probably located in the surroundings of that town, that is, close to modern Udhruh (Arjava *et al.* 2007: 33–40; P. Petra III:19, 1–2 Comm.). The Petra Papyri do not mention the existence of independent small holders. Then again, rather than reflecting contemporary reality, the lack of information may result from the selective nature of the archive. The abandonment of single farmsteads cannot be interpreted as direct evidence that all privately owned agricultural land belonged to the elite of Petra and other towns of the region.

The average size of the Petraeans' landed properties is likewise difficult to judge. Due to the nature of the documents, the properties mentioned in the papyri usually represent only a part of the total of landed properties of a family or an individual. Furthermore, although the land is measured in *iugera*, the size of the units of measurement seems to vary from one document to another, perhaps depending on the productivity of the land or the type of crops cultivated (see Frösén *et al.* 2002: 101–104). Koenen (1996: 184) calculated the total size of the property divided in Papyrus Petra 17 as 85 acres (34.4 hectares), which together with the other properties of the family mentioned in the same papyrus adds up to 134 acres (54.23 hectares).[31] He conceded that there may well have been other properties not mentioned in the document.

The information concerning the actual management of the properties is meagre in the papyri. Nonetheless, the impression conveyed by the archive is that the landowning families of the Petra Papyri did not, for the most part, farm their land themselves but instead leased the fields and vineyards to lessees and tenants who took care of the cultivation (Koenen 1996: 184; Gagos and Frösén 1998: 480). The size of the allotments received by the inheritors in Papyrus Petra 17 ranges mainly from ½ to 5 *iugera* (roughly 0.13–1.315 hectares). Many of these were leased, but the names of the tenants have rarely been preserved, which makes it impossible to estimate the total area a tenant was farming. Foxhall (2003: 81–83) has estimated, using historical and ethnographic data from Greece and Italy, that in ancient Greece, the maximum area of arable land that could be feasibly cultivated by a single family unit without outside labour was ca. 5-6 hectares. If the rotation of crop and fallow is practised, the total arable area could be twice that. This area would not, however, enable surplus production of grain. The estimate does not take into account the land planted with trees or vines. Other estimates (White 1970: 336) have placed the minimum size of a subsistence holding for a family at around 20 *iugera* (ca. 5.25 ha). It could therefore be expected that the tenants had to farm larger areas than this to produce surplus to be able to pay the lease, whether in farm products or in cash (from selling the surplus). Furthermore, the crop yields from dry farming in the Petra region are poorer than in Italy or in Greece, which indicates that under dry cultivation, more land would be needed to produce even the grain needed to meet the subsistence level. On the other hand, the productivity of the land could be considerably increased by the use of run-off farming.

[31] An estate of 80-500 iugera (21-131.5 hectares) is considered a medium-sized property in the classification in White (1970: 387–88).

The period of a lease in the Petra Papyri seems to vary, perhaps depending on the crops cultivated, but there is no information about the rents paid and whether they were paid in kind or in cash (Koenen 1996: 184). Banaji (2001: 46–88) has argued, with examples from Syria and Egypt, that a monetary economy was, in fact, more widespread in the countryside of the Byzantine East than was formerly thought. The Petra Papyri do not shed much light on the question of the use of money in the Petra region. Although there are several documents concerning matters related to taxation, in most of them there is no mention of how the taxes were paid. However, there is a group of tax receipts (P. Petra I:7–10), where it is clearly stated that the taxes were paid in farm products. These taxes were probably related to the payments for *annona militaris* (P.Petra I:7, 4 Comm.). Another group of tax receipts (P. Petra III:32–34) specifically concerns taxes paid in gold, apparently to members of the curial class who were part of the city administration (Gagos and Caldwell 2007). However, these documents record taxes paid by people belonging to the wealthy landowning class and cannot be taken as evidence for the widespread use of money throughout the society. Notably, the number of coins found in the archaeological excavations in Petra drops sharply from the 4th to the 5th and 6th centuries (Fiema 2002a: 227–28; Parr 2007: 297).

Vineyards are occasionally listed in the texts (Koenen 1996: 183; P. Petra 17; P. Petra III: 9, 3–4 Comm.), confirming that viticulture continued to be practised in the Petra region even though the archaeological evidence for it is limited. However, it is likely that the main crops were grains, particularly wheat (Koenen 1996: 181). A number of threshing floors are mentioned in P. Petra 17 as part of the inheritance, suggesting that at least the large landowners privately owned these installations, although it does not rule out the existence of threshing floors collectively owned and used by villagers.

Considering the importance of olive as a cash crop in the late antique East, it may appear surprising that indications for oleaculture can be found in only one of the Petra Papyri, which mentions oil presses together with tree-bearing plots – presumably olive groves (P. Petra III:36, 105–108, 127–30). The Petra region probably could not compete with the neighbouring areas in olive oil production – both Syria and Palestine produced olive oil for export during the Late Roman and Byzantine period (Banaji 2001: 18–19). Moreover, it seems unlikely that the Petra region was ever a major exporter of agricultural produce. The surplus produced was probably marketed within southern Jordan.[32] This does not, however, rule out the involvement of wealthy individuals in agricultural pursuits in other regions – at least one of the Petraean landowners had properties as far away as Gaza (Gagos and Frösén 1998: 476; Frösén *et al.* 2002: 36).

The Petra papyri do not unambiguously mention terracing or other structures related to run-off farming, although some fields are mentioned to be "above" or "below" others, which indicates that they were on a slope and therefore possibly terraced. The generally small size of the individual fields, from ½ to 5 *iugera*, can also be interpreted as indirect evidence of small terraced plots of land (Koenen 1996: 184–85). On the other hand, they may have been similar to the field systems seen in the Jabal ash-Shara

[32] Archaeological evidence suggests that trade contacts existed between ʿAila (ʿAqaba) and Petra in the Byzantine and Early Islamic periods (Holmqvist 2010; Holmqvist and Martinón-Torres 2011; Studer 2008).

area at present: relatively narrow strips of ploughed fields cleared of stones, separated by stretches of stony soil (see Fig. 7).

Excursus: Villas

As noted before, sites that would have been recognized as rural *villae* are not known in most of the Province of Arabia (Graf 2001a: 228–29). The excavated 'Nabataean villas' in the modern Wadi Musa area ('Amr *et al.* 1997; 'Amr and al-Momani 2001: 266–67) have apparently been so called due to their architecture and decoration, which includes luxury elements, such as mosaics and baths, that would be found in a Roman *villa urbana*. However, since they apparently predate the annexation, to interpret them as *villae* is, to my mind, misleading, although they may indeed have their examples in Roman suburban *villae*. Likewise, we do not have any evidence from surveys of such large complexes that could be considered the central buildings of *villa* estates during the later periods, although admittedly the lack of excavation and the poor preservation of the surveyed remains may influence the interpretations. However, the information in the Petra papyri does not conclusively point towards the existence of *villae* as agricultural establishments. The large landowners apparently owned many houses, which were located either in villages or as separate farmsteads (P.Petra 17). These appear to have been relatively large building complexes, usually subdivided into living spaces for more than one family, which raises the question of how to recognize them in a surface survey. However, there is little indication in the papyri that these buildings functioned as *centres of agricultural production* (cf. Purcell 1995: 167; 172–173), although they no doubt also had an agricultural role besides the residential one.

The apparent lack of archaeologically observable large estates finds an explanation in the Petra Papyri. A special feature of large-scale land ownership in Petra seems to have been that the landholdings consisted of a collection of relatively small individual plots, geographically widely distributed, rather than forming compact estates (P. Petra 17; Koenen 1996: 183–84). Koenen (1996: 185) has suggested that this was a risk-management strategy adapted to the semi-arid environment where rainfall is temporally and spatially extremely variable from year to year. Another factor, which probably contributed to the wide geographical distribution of landed properties, was the tradition of dividing property by casting lot as was done in the case of the inheritance divided among the three brothers in Papyrus Petra 17 (Koenen 1996: 183).

CHAPTER 10. – SYNTHESIS AND CONCLUDING REMARKS

It can be seen that although the corpus of archaeological evidence pertaining to rural settlement in the Petra region has expanded, the picture still agrees with what Fiema presented two decades ago. Nabataean settlement radiated out in all directions from Petra, but rural settlement contracted by the 3rd century and began to concentrate in the area of Jabal ash-Shara. A shift of the focus of rural settlement towards the east can be seen already beginning in the 4th century, but becoming clearly visible in the 6th century. Over the same period of time, an almost complete disappearance of settlement hierarchy takes place, with rural settlement concentrating in villages.

Unlike the Nabataean-Roman period, when Petra was the leading metropolis in the area, surrounded by consecutively smaller communities down to isolated farmsteads, the Byzantine period witnessed the establishment of a very different settlement pattern, with villages and small towns, particularly in the Jabal ash-Shara area and in the eastern parts of the Petra region. Although Petra still held an eminent position among those towns, the importance of Udhruh/Augustopolis in particular had clearly grown. The Late Byzantine proliferation of rural settlements was, however, short-lived. It seems that many of the rural settlements newly established or reestablished in the 6th century were already abandoned by the 7th century. In the course of the 7th century, settlement in the Petra region seems to become even more strongly concentrated into a few towns and large villages, such as Udhruh ('Adhruh), Jarba, Ma'an and Khirbat an-Nawafla, with a distinct preference for the eastern part of the region – a pattern which seems to continue through the Early Islamic period.

The emergence of permanent rural settlement and agriculture in the Petra region in the last centuries BC can be seen as the result of the gradual transformation of Nabataean society through the wealth generated by trade and contacts with sedentary peoples. This development resulted in the growth of settled population in Petra and increased social complexity, including occupational specialization, which also produced the distinctive material expressions of the Nabataean culture. The growing sedentary population and craft specialization also caused an increased demand for agricultural supplies, creating a need for the intensification of cultivation. Based on an ethnographic analogy, it can be postulated that along with increased sedentarization, also the perception of agricultural land was changed from a communal resource, with right of use allocated through kinship, to private ownership.

Considering the archaeological evidence, it can be seen that the rapid intensification of agriculture that is manifested in the increase in the number of rural settlement sites, particularly in the Escarpment and Jabal ash-Shara zones, is generally contemporary with the urban expansion of Petra in the last decades BC–early decades AD. The urbanization of Petra and the growth of its population were undoubtedly linked to the peaking of the economic and political influence of the Nabataeans. The growth of urban population and the need to supply the caravans fuelled the almost explosive increase in rural settlement and intensification of agriculture, unparalleled in the Petra region, in the 1st century AD. The increased social stratification in Nabataean society is visible in both the funerary and domestic architecture, and although it is not possible to observe any signs of the concentration of landed properties in the archaeological data, it can be suggested that the uneven distribution of wealth is also reflected in the variability of small rural sites.

In contrast to the apparently rapid expansion of sedentary occupation and agriculture in the 1st century AD, the decrease in rural settlement in the Petra region was not a sudden phenomenon but a process that extended over several centuries, starting as early as the latter part of the 2nd century AD and continuing through the period of time considered here.

The disappearance of small settlements can be taken as evidence of the concentration of landownership into fewer hands, but the archaeological evidence for changes in land tenure during the 3rd–4th centuries is somewhat ambiguous, since the number of large sites also drops and there seem to be breaks in the occupation even at some large settlements in the Jabal ash-Shara area. On the other hand, while the abandonment and discontinuity of settlement in the 3rd century is a region-wide phenomenon, the numbers of settlements already begin to increase in the eastern part of the Jabal ash-Shara area in the 4th century, when many abandoned settlements are resettled and some of them also grow in size. This disparity of development between the western and eastern part of the Jabal ash-Shara area suggests relocation of population within the region in the 4th century. The simultaneous growth of large sites may indicate an increase in the settled population after the 3rd century and/or settlement nucleation.

If we follow the line of thought that the initial emergence of rural settlement in the Petra region was related to the intensification of agriculture primarily as a response to the need to produce surplus for consumption by the citizens of Petra and the passing caravans, we could propose that its decline was related to the same factors. The disturbances in the long-distance trade and changes in the pattern of the main trade routes in the 3rd century affected the economy of Petra, as indicated by the cessation of the manufacture of unguents. Although there is archaeological evidence that interregional commerce still had some role in the economy of Petra in the 4th century, the urban area of Petra seems to have been decreasing, perhaps indicating a decline in prosperity and even in the urban population. The dwindling of rural settlement in its entirety probably reflects these contemporary trends in the main urban centre of the region. It could be suggested that with less need for surplus production, many farmers returned to a more mobile way of life, with extensive subsistence cultivation practised alongside herding. The nearly complete withdrawal of permanent settlement from the

western periphery of the region that had taken place by the beginning of the 5th century can be directly linked to the cessation of interregional trade since the large settlements in Wadi 'Araba were probably not primarily agricultural in character, but related to the caravan traffic from Petra to Gaza.

On the other hand, the decrease in rural settlement began earlier than the evidence we have for the diminishing volume of long-distance trade. Therefore, I suggest that we are dealing with two phenomena partially overlapping in time. The first is the concentration of landed properties, which begins during the 2nd century AD at the latest. The second is a move to a more mobile agricultural strategy of combined herding and extensive cultivation in the 3rd century. In turn, these are followed by the nucleation of rural settlement, archaeologically discernible in the Jabal ash-Shara area during the 4th and 5th centuries, which is related to the reorientation of the economy to agricultural production and the further concentration of landed properties into fewer hands through inheritance, marriages and purchases of land. The results of this development are attested in the 6th-century Petra Papyri.

It is, however, largely the decrease in the number of rural sites in the Jabal ash-Shara area that has created the former picture of a decline in Byzantine settlement within the Petra region. It has been suggested that the incentive for the seeming eastward shift in settlement focus may be related to increased economic opportunities at the edge of the eastern desert, related to the caravan routes from the northern Hijaz to Syria and Palestine passing through the area (Fiema 2002a: 233–34; 2003: 51–52), and this seems a likely factor, but only partially explains the phenomenon. The abandonment of the best agricultural land in the region fits poorly with both the archaeological evidence for agricultural expansion into the marginal lands between Udhruh/Augustopolis and Ma'an and with the textual information from the Petra Papyri, which indicates that the economy of the region was oriented towards local agricultural production. The proliferation of sites in all size categories, which can be observed in the eastern part of the Petra region in the 6th century, is, on the other hand, in perfect accordance with the intensification of agricultural activities in the area and resembles the situation in central and northern Jordan and the Negev in the Byzantine period, albeit on a smaller scale.

Furthermore, it can be argued that the establishment of agricultural settlements on the eastern periphery of the Petra region in the 5th–6th centuries probably did not take place at the initiative of independent small farmers. The construction of the extensive run-off cultivation systems associated with these settlements indicates a considerable need for workforce, and possibly also capital. Foxhall (2003: 77–79) has argued that the opportunities for small holders to expand their production were limited by the lack of workforce and capital.[33] On the other hand, as also Findlater (2002: 144) has pointed out, the agricultural expansion into this marginal landscape surrounding Udhruh/Augustopolis and Ma'an took place in an environment of generally shrinking imperial control of the region, which suggests it was not a state-controlled enterprise but arose from the local economic dynamics.

[33] Foxhall (2002: 216–17) has further argued that it was their (pre-)existing wealth in the first place that enabled the elite to cultivate more land through access to more labour, and that in the long term, this unequal access to extra labour resulted in the concentration of landed properties.

If we were to consider the archaeological data alone, without the information from the papyri, it would be difficult to confirm indisputably the concentration of landownership and the existence of large landowners in 6th-century Petra, although this might be implied by the information available from other regions of the Byzantine East. This underlines the way in which the historical information from the Petra Papyri greatly influences the picture we get of the rural landscape in the Byzantine period. Although the nucleation of settlement points toward the concentration of landed properties into fewer hands, the lack of archaeological evidence for large estates, which would signify concentrated landownership, could indicate other explanations, such as a severe population decline (Hart and Falkner 1985: 268; Graf 2001b: 474) or a breakdown in security (Parker 1986: 637–39; 648), both of which have been suggested previously as the cause of the decrease of sites south of Wadi al-Hasa during the Byzantine period. However, if we consider the archaeological evidence presented above, it can be seen that neither of these explanations is entirely satisfactory. The newly established large settlements in the Jabal ash-Shara area and particularly on the eastern margin of the Petra region during the Late Byzantine period call into question the supposed decline in population. As for the apparent shift of the focus of settlement towards the edge of the eastern desert, quite the opposite should be expected in the face of an increased external threat from the east.

If we now reconsider the archaeological evidence from the Jabal ash-Shara area, it can be seen that although the total number of sites was decreasing during the Byzantine period, the number of village-sized settlements increased. Furthermore, the information in the Petra Papyri indicates that the arable land surrounding abandoned hamlets was continuously kept under cultivation. In my opinion, the Byzantine settlement pattern in the Petra region should therefore not be seen as mirroring a decline in population and rural activity, but quite the opposite: it is the result of the increased importance of agricultural pursuits for the local economy, the concentration of landownership and the relocation of the rural population associated with these economic and social changes. In this light, the expansion of agricultural settlement to the environmentally marginal lands in the eastern part of the Petra region becomes comprehensible. If most of the best arable land in the region was already in the hands of large landowners, whether private or institutional, the direction for agricultural expansion and development lay to the east of Jabal ash-Shara.

The evidence for agricultural intensification in the Petra region in the Byzantine period agrees with what we know about northern and central Jordan, and the Eastern provinces in general during that period. The resultant pattern of nucleated settlement and extensive cultivation, however, differs from the other Eastern provinces, which were generally characterized by intensive agricultural practices and an overall increase in rural settlements of all sizes. The reasons behind the different trajectory taken by the Petra region are likely to be multiple. They include such factors as the restricted availability of prime farmland due to the local environmental conditions and traditions of land use and inheritance, which contributed to the geographical fragmentation of estates, as well as the extensive management of landed properties through tenant farmers by the city-dwelling elite, whose interests lay in the acquisition of more arable land

rather than employing more intensive cultivation methods to produce surplus. Ultimately, the settlement pattern change seen in the hinterland of Petra from the Late Roman to the Late Byzantine period is closely related to the economic and social change brought about by the termination of interregional trade through Petra after the 3rd–4th centuries AD, which resulted in the isolation of the economy of Petra, and an overall regionalization, which is also reflected in the pattern of the rural settlement.

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Abbreviations:

ADAJ: Annual of the Department of Antiquities of Jordan

BASOR: Bulletin of the American School of Oriental Research

IEJ: Israel Exploration Journal

JAS: Journal of Archaeological Science

JFA: Journal of Field Archaeology

JMA: Journal of Mediterranean Archaeology

JRA: Journal of Roman Archaeology

PEQ: Palestine Exploration Quarterly

ZDPV: Zeitschrift des deutsches Palästina Vereins

ZPE: Zeitschrift für Papyrologie und Epigraphik

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SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Bayda 11; Kh. an-Naq'a	L			L	L		L	L	L			Amr *et al.* 1998: 507	village, wine press
Bayda 15	M			M	M			M	M			Amr *et al.* 1998: 510	cisterns, channels, wall lines, foundations
Bayda 16	M				M	M	M	M				Amr *et al.* 1998: 510	cultic installations, wine presses etc., wall lines
Bayda 20	M			M	M	M	M	M				Amr *et al.* 1998: 511-12	rock-cut inst., wall lines, cisterns, building blocks, architectural remains
Bayda 21	L			L	L	L	L	L				Amr *et al.* 1998: 512	many structures (wall lines), wine press
Bayda 22	M			M	M	M	M					Amr *et al.* 1998: 512	rock cut inst., abundant wall lines, terraces
Bayda 24	M			M	M	M						Amr *et al.* 1998: 514	small site with several structures
Bayda 28; Kh. al-Qarn	M			M	M							Amr *et al.* 1998: 515	fortress(?), other substantial buildings
Bayda 32	S			S	S	S						Amr & al-Momani 2001: 256	a complex structure (building remains)
Bayda 34	S			S	S	S						Amr & al-Momani 2001: 256	wall lines, a structure (house?)
Bayda 37	S			S	S	S						Amr& al-Momani 2001: 256	substantial structure, wadi barriers, cistern
WM 9; Kh. an-Nawafla	L		L	L	L	L	L	L	L	L	L	Amr *et al.* 1998: 519-20, 'Amr *et al.* 2000	agricultural village
WM 18; Gaia	L		L	L	L	L	L	L	L	L	L	Amr *et al.* 1998: 522-26; Amr & al-Momani 2001:264; Amr *et al.* 1997	extensive settlement site JADIS 1997.003
WM 19; Kh. Bani 'Ata	M			M	M	M			M	M	M	Amr *et al.* 1998: 526	village
WM 21; Kh. Subhiyya	M			M	M					**M**	**M**	Amr *et al.* 1998: 527-28	settlement site, built over, JADIS 1997.009
WM 23	S	S	**S**	**S**	**S**							Amr *et al.* 1998: 529	single building remains
WM 26	S			S	S							Amr & al-Momani 2001: 269	single building remains - farmstead

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
WM 27	S			S								Amr & al-Momani 2001: 269	multi-room structure, burial
WM 30; Al-Muzayr'a,	M					M						Amr & al-Momani 2001: 269-70	several large structures
WM 32	S					S						Amr & al-Momani 2001: 270	single building remains
Tayyiba 5	S				S		S				**S**	Amr *et al.* 1998: 533	small rectangular structure
Tayyiba 6; Kh. Braq	L			L	L	L	L	**L**	**L**	**L**	**L**	Amr *et al.* 1998: 533	extensive village site
Tayyiba 7	S			S	S	S	S	S	S			Amr *et al.* 1998: 533	wall lines, settlement of uncertain extent
Tayyiba 8	S			S	S	S						Amr *et al.* 1998: 534	wall lines, uncertain extent (disturbance)
Tayyiba 9	L			L	L	L		L	L			Amr *et al.* 1998: 534	Khirbat Hama, extensive settlement
Tayyiba 10; Kh. Hubays	L			L	L	L	L	L	L			Amr *et al.* 1998: 534	large, complex settlement site
Tayyiba 12; Kh. Dhba'	L			L	L	L				L		Amr *et al.* 1998: 535; Amr & al-Momani 2001: 273-74	extensive settlement site
Tayyiba 14	S			S	S		S	S	S			Amr & al-Momani 2001: 274	remains of small structures & fields
Tayyiba 15	M			M	M	M						Amr & al-Momani 2001: 274-75	several wall lines, cistern
Ayl 2; Kh. al-Mabrak	L			L	L	L	L	L	L	L		Amr *et al.* 1998: 537-38	extensive site, several structures, cistern
Ayl 3	S			S	S							Amr *et al.* 1998: 538	single large building remains
Ayl 5; Kh. Ayl	L			L	**L**	**L**	**L**	**L**	**L**	**L**	**L**	Amr *et al.* 1998: 538-39; Abudanh 2006: 504-505	complex settlement, built over by trad. village; also in Abudanh 2006 (192)
Ayl 10	S			S	S	S	S	S	S			Amr & al-Momani 2001: 277-78	several walls, cistern
Qa' 2	S			S	S							Amr *et al.* 1998: 540	single large building remains
Qa' 3	S			S	S		S					Amr *et al.* 1998: 540	rectangular complex with internal divisions
Qa' 4	S			S	S							Amr *et al.* 1998: 541	rectangular building with internal divisions
Qa' 5	S			S	S							Amr *et al.* 1998: 541	rectangular structure (house?)

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Qa' 6; Umm at-Tiran	M			M	**M**	**M**	**M**	**M**				Amr *et al.* 1998: 541-42	extensive site with many structures; also in Abudanh 2006 (076)
Qa' 7	S			S	S	S	S					Amr *et al.* 1998: 542	complex structure with internal divisions
Qa' 8	M				M	M	M					Amr *et al.* 1998: 542-43	structures on a hill, modern trad. houses
Qa' 9; Bi'r al-Bitar	L			L	L				L	L		Amr *et al.* 1998: 543	several structures
Qa' 10; ar-Rasif	M			M	M	M	M					Amr *et al.* 1998: 543	junction of three ancient roads, cistern, walls
Qa' 12; Tell'et Eisa	M			M	M	M						Amr & al-Momani 2001: 282	Nab/Roman hamlet, two cisterns; also in Abudanh 2006 (098)
Abudanh 003	S			S	S	S						Abudanh 2006: 399	farmhouse
Abudanh 006	S						S	S	S			Abudanh 2006: 401	fort, Byzantine settlement
Abudanh 007; Kh. Malghan	M/L			M	M		L	L	L			Abudanh 2006: 217, 219, 401,	small village 300x250 m, threshing floors - larger in Byzantine period
Abudanh 008	S			S	S							Abudanh 2006: 402	farmhouse
Abudanh 010; Kh. al-Qumaid	M			M	M	M	M	M	M			Abudanh 2006: 402-403	two farmhouses
Abudanh 012	S			S	S		S	S	S			Abudanh 2006: 404	large circular mound and a building
Abudanh 017; Kh. Qrah	M			M	M				M	M		Abudanh 2006: 406-07	two farmhouses with internal divisions
Abudanh 023; Kh. al-Nmaileh	M			M	M	M			M	M		Abudanh 2006: 408-09	hamlet - structure, threshing floors, cave
Abudanh 024; Kh. al-Akhshan	M			M	M							Abudanh 2006: 410	farmsteads; two rectangular structures
Abudanh 025; Kh. al-Trabsieh	M			M	M				M	M	M	Abudanh 2006: 410-11	two farmhouses
Abudanh 027; Wadi al-Harab	M			M	M	M	M	M	M			Abudanh 2006: 411	at least two ancient rectangular structures, covered by modern trad. houses

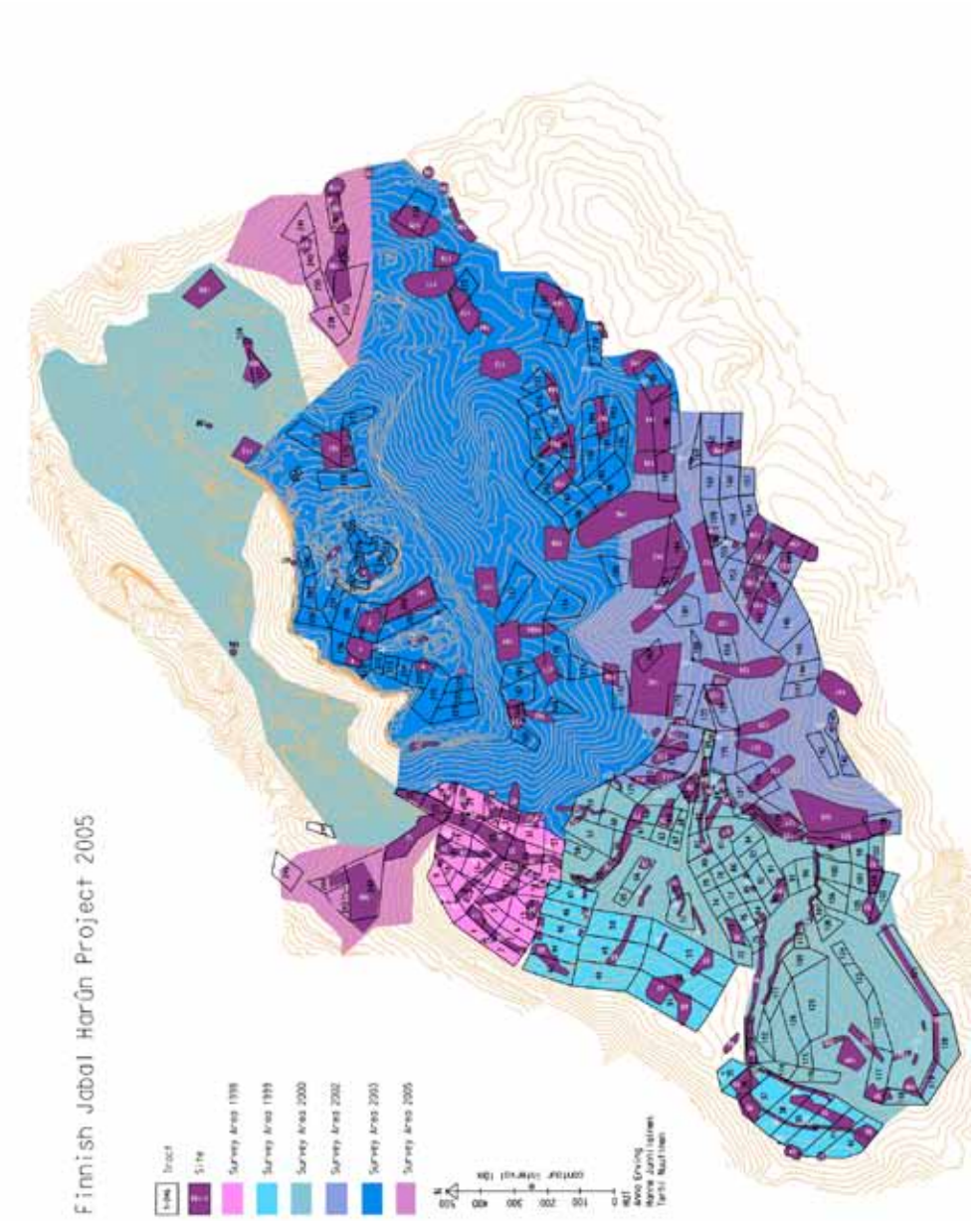
SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Abudanh 029; Kh. al-Jerba	L			L	L	L	L		L	L	L	Abudanh 2006: 412-13	village/town
Abudanh 044	M				M	M						Abudanh 2006: 419-20; Abudanh 2003: 58	hamlet , two structures
Abudanh 045	S								S	S	S	Abudanh 2006: 420-21	two towers, later used for habitation
Abudanh 046	S					S	S	S	S	S	S	Abudanh 2006: 421-22	caves and a structure 31x17m with internal divisions
Abudanh 050; Udhruh	L			L	L	L	L	L	L	L	L	Killick 1983	legionary fortress and settlement
Abudanh 056; Kh. Rbai'	S			S	S	S			S	S		Abudanh 2006: 428-29	farmstead
Abudanh 058	S			S					S			Abudanh 2006: 429-30	small farming structure; farmstead
Abudanh 059	S			S	S	S						Abudanh 2006: 430	farmstead, trad.house
Abudanh 060	S					S			S	S		Abudanh 2006: 430	trad. houses at an ancient site (19x19 m)
Abudanh 069	S			S	S	S						Abudanh 2006: 435	farmstead
Abudanh 072	S			S	S							Abudanh 2006: 437	farmstead
Abudanh 074	S			S	S							Abudanh 2006: 437-38	farmstead
Abudanh 075	S			S	S							Abudanh 2006: 438	farmstead
Abudanh 077; Abu Tiran	S			S	S	S	S	S				Abudanh 2006: 439	farmstead, threshing floors
Abudanh 083	S			S	S							Abudanh 2006: 440-41	farmstead, threshing floors
Abudanh 086	S			S	S							Abudanh 2006: 442	irregular structure (farmstead)
Abudanh 088; al-Juri 1	S			S	S		S	S	S			Abudanh 2006: 443-44	hamlet – a single structure
Abudanh 089	S			S	S	S	S	S	S	S		Abudanh 2006: 444-45	farmstead
Abudanh 090	S			S	S		S	S	S			Abudanh 2006: 445	farmstead

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Abudanh 092; al-Juri2	S			S	S							Abudanh 2006: 221, 446-47,	farmstead
Abudanh 106; Kh. al-Hazahzeh	M		M	M	M		M	M	M			Abudanh 2006: 454	hamlet 150x70 m
Abudanh 109; Umm al-Futtus	S			S	S		S	S	S			Abudanh 2006: 456	farmstead, two threshing floors
Abudanh 111	S			S	S	S	S	S	S			Abudanh 2006: 457	farmstead
Abudanh 112	S			S								Abudanh 2006: 457	farmstead
Abudanh 115	S			S	S							Abudanh 2006: 459-60	farmstead
Abudanh 116	S			S	S				S	S	S	Abudanh 2006: 460	farmstead
Abudanh 118	S			S	S							Abudanh 2006: 461	farmstead
Abudanh 121	S			S	S							Abudanh 2006: 462-63	farmstead
Abudanh 122	S						S	S	S			Abudanh 2006: 221, 463-64,	farmstead/road station
Abudanh 126	S			S	S							Abudanh 2006: 467	farmstead, 2 threshing floors
Abudanh 133; Kh. Umm al-Jarad	M			M	M	M			M	M		Abudanh 2006: 469-70	hamlet? large multiroom structure, later additions
Abudanh 135	S			S	S							Abudanh 2006: 471	farmstead
Abudanh 138	S			S	S							Abudanh 2006: 472	farmstead
Abudanh 140	S			S	S		S	S	S			Abudanh 2006: 473	farmstead
Abudanh 143	S			S	S		S	S	S			Abudanh 2006: 475-76	farmstead
Abudanh 145	S				S							Abudanh 2006: 477. 210	road station/farmstead
Abudanh 147; Kh. Tell'et 'Eli	M			M	M							Abudanh 2006: 478-79	small village
Abudanh 149	S			S	S							Abudanh 2006: 480	farmstead
Abudanh 160	S			S	S	S			S	S	S	Abudanh 2006: 486-87	farmstead
Abudanh 163	S				S			S	S			Abudanh 2006: 488	farmstead
Abudanh 166	S			S	S		S	S	S			Abudanh 2006: 489-90	farmstead

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Abudanh 168	S			S	S	S						Abudanh 2006: 491-92	farmstead
Abudanh 170	S				S	S						Abudanh 2006: 492-93	structure/farmstead
Abudanh 175	S			S	S							Abudanh 2006: 495	irregular structure (farmstead)
Abudanh 176	S			S	S							Abudanh 2006: 496	farmstead
Abudanh 178	S			S	S							Abudanh 2006: 497-98	farmstead
Abudanh 184; Ayn Muhaidhrat	M			M	M							Abudanh 2006: 500	ancient and trad. village
Abudanh 185	S			S	S							Abudanh 2006: 501, 207, 213	farmstead/fort
Abudanh 197	S								S	S	S	Abudanh 2006: 507, 221	tower, farmstead
Abudanh 202	S						S	S				Abudanh 2006: 509, 221	structure/road station; farmstead
Abudanh 210	S			S	S							Abudanh 2006: 512-13	trad. house on ancient structure (farmstead)
Abudanh 216; Jabal at-Tahuna	L							L	L	L	L	Abudanh 2006: 515, 216-17; Abudanh 2003: 65; Killick 1986: 438-40	village/town
Abudanh 218; Kh. Abu Danna	M/L			M	M		L	L	L			Abudanh 2006: 515-16	trad. village, ancient settlement
Abudanh 223; Kh. Abu Qumrah	M			M	M	M	M	M	M			Abudanh 2006: 518-19	hamlet
Abudanh 230	S			S	S							Abudanh 2006: 522	farming structure, 15x15 m
Abudanh 233	S			S	S		S	S	S			Abudanh 2006: 207, 523	watchpost to secure a spring; farmstead
Abudanh 240	S				S							Abudanh 2006: 526	irregular collapsed structure, farmstead,30x20 m
Abudanh 247	S			S	S							Abudanh 2006: 529	farmstead
Abudanh 257	S				S	S						Abudanh 2006: 533-34, 214	farmhouse (a complex structure + two caves), 50x70 m
Abudanh 258	S			S	S				S	S		Abudanh 2006: 534	farmstead

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
Abudanh 259	S			S	S							Abudanh 2006: 534-35	hamlet (or farmstead, 1 structure) 50 x 50 m
Abudanh 261	S								S	S		Abudanh 2006: 535-36	square structure, Ayn al-Ashra
Abudanh 269	S			S	S							Abudanh 2006: 539	farmstead
Abudanh 270; Kh. Sabbah	M			M	M				M	M		Abudanh 2006: 539-40	small village
Abudanh 272	S			S	S	S	S	S				Abudanh 2006: 540-41	farmstead
Abudanh 276; Kh. al-Rwaiha	M/L				M		L	L	L			Abudanh 2006: 210, 214, 542-43	hamlet
Abudanh 280	S			S	S	S						Abudanh 2006: 544	farmstead
Abudanh 281	S				S							Abudanh 2006: 545	farmstead
Abudanh 282	L			L	L	L	L	L	L	L		Abudanh 2006: 545	town & military fort, Sadaqa
Abudanh 287	S			S	S		S	S	S			Abudanh 2006: 548	farmstead, 15x20 m
Abudanh 289; Kh. Whaideh	S			S	S							Abudanh 2006: 549	trad. house, rectangular structure
Abudanh 290	S					S						Abudanh 2006: 214, 549-50	irregular structure, caves, enclosures - farmstead
Abudanh 317	S			S	S							Abudanh 2006: 561	structure, well, threshing floor
FJHP site 43	S			S	S								building remains
FJHP site 49	S			S	S								large building remains - single farmstead
FJHP site 109	M			M	M		M	M	M	M	M		building complex - two or more buildings
FJHP site 128	M		M	M	M								building complex – hamlet/large farm-stead
FJHP site ext116	S				S	S	S						building remains - small farmstead
FJHP site ext125	S			S	S								building remains - small farmstead
FJHP site ext134	S		S	S	S								building remains - small farmstead
FJHP site ext073	M			S	S		S						building complex

SITE	SIZE	2 BC	1w BC	1 AD	2 AD	3 AD	4 AD	5 AD	6 AD	7 AD	8 AD	REFERENCES	SHORT DESCRIPTION
FJHP site ext075	S		S	S									remains of two buildings - may not have been used contemporaneously
FJHP site ext081; Abu Khushayba	L			L	L	L	L					Lindner 1992: 264-65	village (10-11 buildings)
FJHP site ext052-057	M			M	M								hamlet - at least two separate buildings, cisterns, wine press, cemetery (ath-Thugra)
Sabra	L			L	L	L	L					Lindner & Zeitler 1997/98	settlement, monumental architecture
Umm Ratam	M		M	M	M	M	M					Lindner 1998: 27;Lindner *et al.* 2000: 549-50; King *et al.* 1989: 205-207; Lindner *et al.* 2007	fortification and hamlet
Bir Madhkur	M			M	M	M	M	M				King *et al.* 1989: 205; Graf 1992: 259; Smith 2005	hamlet, military complex
Wadi as-Sadeh	M			M	M	M						Lindner *et al.* 1988; Lindner *et al.* 1990:199; Lindner 2003: 184-87	Nabataean village



Map 8. Tracts and sites in the FJHP survey (H.Junnilainen, A. Annila/Institute of Photogrammetry and Remote Sensing, Aalto University/FJHP)