Chapter 9
Empire and Environment in the Northern Fertile Crescent

Tony J. Wilkinson

9.1 Introduction

Because of their huge size, empires are daunting for archaeological study. Although some features of early Near Eastern empires have been studied since the very earliest trenches were sunk into the Assyrian capital cities of Nimrud and Nineveh (Fig. 9.1), the implications of the development of territorial empires have not been fully absorbed into the study of human-environment relations. The later territorial empires of the first millennium BC and AD fundamentally changed the landscapes of the Near East in ways that did not previously obtain. For example, features of monumental scale (which are often associated with empires), and which include huge canal systems such as those of the Sasanians, necessarily had massive impacts on the environment, but more widespread, and ultimately perhaps more significant in terms of human impacts on the environment, are the smaller scale features that are often under-represented by archaeologists. This chapter relates the signatures of the cultural landscapes of the later territorial empires of the Near East to the local environment and landscape degradation.

Empires provide the opportunity to relate socio-political processes explicitly to environmental conditions and more specifically to evaluate the links between humans and the environment. Nevertheless, because of their size and administrative complexity the recognition of causal links may be difficult. Territorial empires can be defined as territorially expansive polities in which a ruling power effectively controls and dominates a number of smaller and often weaker subordinate societies and their territories (Doyle 1986). In terms of the landscape, the royal household, ruling out of an imperial capital, has control of vast areas of terrain that can be transformed by the imposition of new patterns of settlement or by the introduction of technological innovations such as irrigation. By so doing, not only do the changes of settlement impact the landscape (by degrading it), innovations such as the introduction of irrigation, can result in the limitations of the environment being ignored or over-ridden.

Examples are drawn primarily from the Neo-Assyrian Empire, the Sasanian Empire in Iran, and the Seleucid, Roman and Byzantine empires in southern Turkey and northwest Syria. The chronological range is from around 900 BC through to the demise of the Abbasid caliphate in the tenth century AD (Table 9.1).

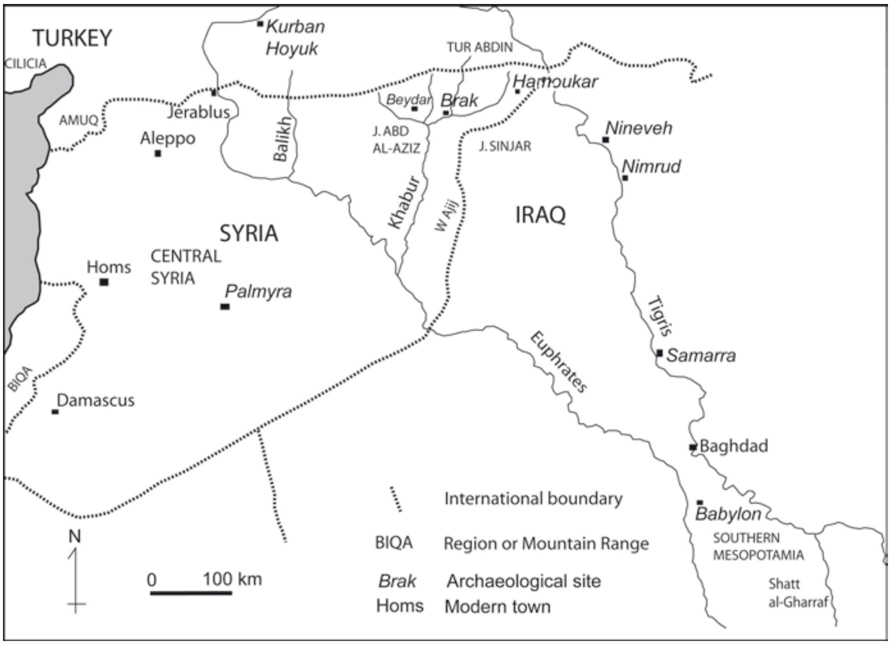
The area dealt with in this chapter occupies that part of the Fertile Crescent in northern Syria, northern Iraq, and southern Turkey where agriculture is primarily dependent upon rainfall. Nevertheless, irrigation became increasingly important from the first millennium BC, and is common today, although frequently today this is at the expense of local water tables that are rapidly falling. Rainfall exceeds 700 mm/annum in the Amanus Mountains flanking the Amuq Valley in southern Turkey (Fig. 9.1), but falls to 300 mm throughout much of the Jazira located between the Tigris and Euphrates rivers, and even less in the semi-desert steppe that fringes the Syrian Desert to the south. Between the Tigris and Euphrates rivers the landscape consists of rolling uplands on Tertiary limestone, sandstone and occasional basaltic outcrops, separated by broad alluvial basins and river valleys, some of which are tributary to the Tigris and Euphrates rivers. Further

T. J. Wilkinson (✉)
Dept. of Archaeology, Durham University
South Road, Durham, DH1 3LE, UK
e-mail: t.j.wilkinson@durham.ac.uk

See Plate 8 in the Color Plate Section; also available at: extras.springer.com

I. P. Martini, W. Chesworth (eds.), *Landscapes and Societies*,
DOI 10.1007/978-90-481-9413-1_9, © Springer Science+Business Media B.V. 2010

Fig. 9.1 Main sites and regions discussed in text



west near the Mediterranean, the Amanus Mountains in Turkey and neighboring ranges in northern Syria are characterized by higher-energy erosional regimes than the steppe lands to the east. During the early and mid-Holocene (Neolithic, Chalcolithic, and Bronze Age), settlement was primarily focused on the broader alluvial plains and valleys, but during the later territorial empires of the first millennium BC and later, settlement spread beyond these core areas into the uplands and out into the more climatically marginal areas of the steppe. Occasional reference is also made to southern Mesopotamia and SW Iran (Khuzestan) where irrigation is essential on the otherwise arid alluvial plains of the Tigris, Euphrates, Karun, and Dez rivers.

The excavation of sites belonging to the ancient empires stretches back to the very beginnings of archaeology and Assyriology, with the excavations by Layard and Botta in the Assyrian capitals of Nimrud, Khorsabad, and Nineveh (Larsen 1994). Only in more recent years have smaller settlements and their landscape context become the focus of investigations. For example, the pioneering studies of David Oates in northern Iraq and Syria focused on both the Neo-Assyrian remains of the first half of the first millennium BC, and also on the Parthian, Sasanian and Roman sites that followed (Oates 1968). Working during the initial years of aerial survey, pioneers such as Mouterde and Poidebard (1945), made the first strides in the mapping of central Syria, subsequently continued on the ground by Bernard Geyer and colleagues (Geyer and Rousset 2001; Geyer et al. 2007). In northern Syria a range of archaeological surveys and geoarchaeological investigations conducted since the 1980s have extended the range of data so that it is now possible to make generalizations from them (Ergenzinger et al. 1988; Wilkinson et al. 2005; Morandi Bonacassi 2000).

During the early days of geoarchaeology, and even before the term had been coined, both Butzer (1964) and Vita-Finzi (1969) had emphasized the genesis of alluvial fills, albeit with rather different conclusions. Thus Butzer saw a more fine grained temporal record and more complex inter-relations between humans and the environment, whereas Vita-Finzi focused on region-wide climatic change as a causal factor. In the Near East, Rosen (1986), Brückner (1986), Goldberg (1998), Cordova (2000) and others have taken an

Table 9.1 The chronology of the main later empires in the northern Fertile Crescent. Note that gaps in the chronology indicate periods of transition

Period	Approximate dates
Neo-Assyrian empire	911–612 BC
Persian/Achaemenid	539–333 BC
Hellenistic/Seleucid (to west)	333–64 BC
Parthian/Arsacid (to east)	247 BC–224 AD
Sasanian (to east)	224–651 AD
Roman (to west)	64 BC–395 AD
Byzantine (to west)	395 AD–636 AD
Umayyad (early Islamic)	661–750 AD
Abbasid (early Islamic)	750–968 AD

approach similar to Butzer, and in recent years there has been an increasing tendency to focus upon the complexity of the relationship between humans and the environment and the role of humans in mediating some of the affects of climatic change (Rosen 2007). Similarly, Bintliff, whose approach originally closely followed that of Vita-Finzi, later adopted an approach that emphasized both human and climatic factors (Bintliff 1992, 2002). Although these pioneering studies were fundamental to the development of the field, because they focused upon the geomorphologic evidence and processes they frequently under represented the record of settlement, which in most studies remained unquantified. Moreover, for a variety of reasons some studies have only been able to focus on valley floor records at the expense of the valley slopes and interfluves that supplied the sediments for the valley floors (Beach and Luzzadder-Beach 2008). Not until the geoarchaeological record was studied in tandem with quantitative studies of settlement during the surveys of the 1980s and later has it become possible to gain a clearer cause and effect relationship between human settlement and associated physical responses (Casana 2008). The primary focus of this chapter is to bring together the results of such investigations over the past 30 years, with particular emphasis upon how the spread of settlement and water supply technology during the later empires contributed to our understanding of interactions between humans and the environment. Nevertheless, it is important to appreciate that settlement and land use configurations respond in many different ways to variations in rainfall, so that it is frequently difficult to separate the effects of climate and humans. In the narrative that follows, the primary attention is paid to the human circumstances that create the conditions for climatic change to operate.

9.2 Case Studies: Settlement Dispersal and Soil Erosion

Although ancient territorial empires are best known for archaeological features of monumental scale, such as the palaces and associated zigurrats of Nimrud and Khorsabad, or the temple-palace complexes of Babylon, Rome, and Ctesiphon, in terms of the landscape, it is often the smaller features that cumulatively have had greatest impact. Whereas nineteenth century archaeological investigations of the Assyrian and Neo-Babylonian empires tended to focus upon the more massive constructions, archaeology in the twentieth century slowly shifted its emphasis to a range of features that were more representative of the entire empire in question. The early Middle Eastern empires were highly centralized and administered by the king, who usually resided in his imperial city, or went out on military campaigns to consolidate and maintain his rule of the outlying provinces. In order to fund the lavish imperial lifestyles, to supply food for their massive populations and to support an army, it was necessary to strengthen the economy and invest in agriculture, often in more far flung parts of the empire. One policy that was particularly common during the Neo-Assyrian Empire was the re-settlement of deportees into marginal steppe lands, many of which were located in the Jazira between the Tigris and Euphrates rivers (Oded 1979). As a result of centralized decisions on geographically marginal areas, local impacts on the landscape (such as deforestation and soil erosion) were often a result of decisions taken in the physically remote imperial capitals. This is very different from the situation that prevailed during the city states of the Bronze Age, when local agricultural decisions were probably most often made by the local king housed in a local settlement (a 'tell').

Neo-Assyrian cuneiform texts provide us with numerous examples of such agricultural policies, many of which appear to be statements of imperial bombast. Some for example, boast of magnificent achievements such as the settling of entire regions by the relocation of large numbers of displaced populations, whereas others describe large land-reclamation schemes and their attended settlements (Radner 2000). Such schemes were difficult to identify during the early stages of archaeological surveys, when techniques were rather coarse, but in recent years field surveys at increasing levels of intensity have demonstrated what appears to be the signature of resettlement schemes. These mainly took the form of areas of small dispersed settlements that dot the landscape in between the earlier and more recognizable pattern of tells. Exemplar landscapes include those north and south of the Jebel Sinjar (NW Iraq), as well as in the Khabur and Balikh Valleys and in the Wadi Ajij near the Iraq/Syrian border (Fig. 9.1; Oates 1968; Bernbeck 1993; Wilkinson 1995; Morandi Bonacassi 2000; Wilkinson et al. 2005).

The settlement landscape of Iron Age Upper Mesopotamia consisted of a broad dispersal of farmsteads,

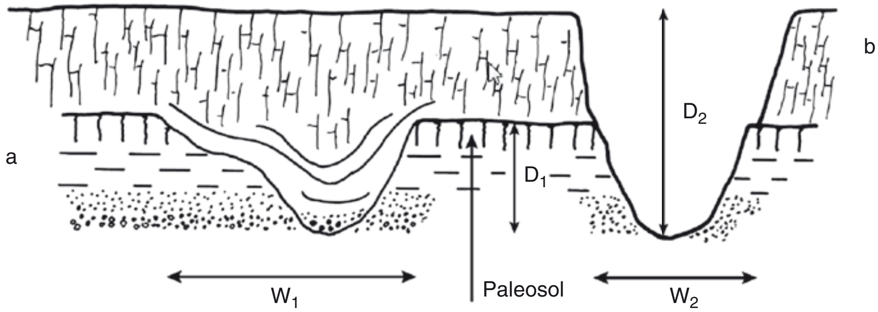


Fig. 9.2 Sketch section through wadi fills in the Wadi Jaghjagh near Tell Brak (D_2 is roughly 6 m, D_1 3 m; W_2 is 10–15 m; W_1 > 15 m). (After Wilkinson 2003)

hamlets and villages with occasional large towns dominated by one massive imperial capital. By no means were all of these settlement schemes imperial foundations: many may have simply resulted from the spontaneous sedentarization of Aramaean nomads who chose to settle under the administrative umbrella of the Neo-Assyrian kings. Nevertheless, this phase of settlement represented a dramatic departure from the characteristic signature of the Bronze Age which consisted of a hierarchical pattern dominated by large tells up to 100 ha area, with progressively smaller centers of power (again 'tells') which formed prominent mounds ranging from 1 to 50 ha in area and 5–30 m in height. The larger Bronze Age tells were distributed between 10 and 30 km apart, whereas the smaller subordinate settlements were usually distributed around the centers. One should not, however, assume that necessarily the largest sites were the most important politically because power relationships between city states could be remarkably fluid. Moreover, the later empires cannot be categorized as homogenous. Rather they comprised a mosaic of administrative entities, satraps, provinces and vassals each of which must have had its own signature on the landscape. Despite these variations, both textual sources and settlement studies demonstrate that there was a shift in the spatial imposition of power between the era of Bronze Age city states and the later territorial empires.

Evidence for the impact of Iron Age settlement on the degradation of the Jazira landscape is ambiguous. Surveys in the Khabur basin around tells Brak, Beydar, and Hamoukar all demonstrate that the dispersal of populations into farmsteads and small villages and lower towns (beneath tells) was in place by the first quarter of the first millennium BC (Morandi Bonacassi 2000; Wilkinson and Barbanes 2000). After the end of the second millennium BC, that is around the onset of the Iron Age or slightly later, the Wadi Jaghjagh near Brak underwent a change of regime from a broader sinuous channel with a grayish silty fill to an entrenched highly meandering channel incised into a brown, blocky clay-rich alluvial fill (Fig. 9.2; Wilkinson 2003). Optically stimulated luminescence (OSL), TL screening, and radiocarbon dating of sediments and carbonized material from the wadis Jaghjagh, Khanzir, and Jarrah provide age estimates on this upper clay fill in the region of 2600 ± 400 BP (OSL), 2600 ± 800 BP (TL screening), 2300 ± 200 BP (OSL) and 2200 ± 900 (TL screening) (Deckers and Riehl 2007). In addition, around AD 244 (1780 ± 30 BP), fragments of wood charcoal in clayey sand in the Wadi Jaghjagh (Deckers and Riehl 2007) suggest that there was localized forest destruction during the Roman/Parthian period. Despite their very broad standard deviations, the OSL and TL estimates broadly support field stratigraphic and artifactual chronologies for these fills (Wilkinson 2003). The upper brown blocky clay fill therefore approximates to the time when the Jazira was becoming heavily re-settled, following a phase of sparse settlement and partial desertion during the late third and part of the second millennium BC. Archaeological surveys and satellite images indicate that starting in the Late Bronze Age, and gaining momentum in the Iron Age, settlements developed on land between tells, which often continued to be settled in the form of lower towns. This dispersed pattern of settlement in the Khabur basin was maintained during the Hellenistic, Roman/Parthian and Byzantine/Sasanian periods and it was during the early Christian period that significant settlement occurred on the hills of the Tur Abdin to the north. In other words not only was the total area of cultivated land increased by the Iron Age dispersal, but also the settlement and cultivation of the hills, (also evident on satellite images), must have resulted in significant erosion of soil into the fluvial system. This erosion, combined with evidence for increased abstraction of water from the Jaghjagh by Partho-Sasanian canal systems, suggests that the main rivers such as the Jaghjagh were receiving both increased sediment loads as well as lower discharges due to abstraction. When combined these factors appear to have contributed to the aggradation of the upper clay fills.

During the first millennium BC, Iron Age settlements extended into parts of the climatically marginal steppe around the Jebel Abd al-Aziz and to the east of the Khabur River (Bernbeck 1993; Hole and Kouchoukos in press), despite the fact that climatic conditions were significantly drier than during the optimum phase of Bronze Age settlement. This is evident from the proxy record of climate from Lake Van, located in eastern Turkey some 100–200 km north of the area in question, which shows that this phase of settlement extension occurred when the climate either experienced significant inter-annual variability, or was somewhat drier than today (Fig. 9.3).

Similar dispersed patterns of settlement prevailed during other phases of territorial empires in the Near East, namely during the Hellenistic, Parthian-Roman, Sasanian-Byzantine, and early Islamic empires, but in these cases the relationship between settlement and valley fills is much clearer. Particularly distinctive landscapes of dispersed settlement are evident along the Euphrates Valley in Turkey and Syria as well as further west in southern Turkey and NW Syria. If aggregate settlement area is used as a proxy indication for population, it appears that in many areas population increased to levels that were significantly above those of the Bronze and Iron Ages. This trend of settlement increase has been observed along the Turkish Euphrates around Kurban and Lidar Höyüks (Wilkinson 1990; Gerber 1996), along the Syrian Euphrates near Carchemish (Fig. 9.4a) (Wilkinson et al. 2007), further west in the Amuq Valley of southern Turkey (Casana and Wilkinson 2005; Casana 2008), in the basalt plateaus north of Homs (Philip et al. 2002), as well as in the Biqa valley of Lebanon (Marfoe 1979). Perhaps more important in terms of landscape degradation, however, is that the number of sites increased even more than overall aggregate settlement area. This meant that areas that had formerly been open steppe, pasture, upland or woodland, received the imprint of very many small settlements, which in aggregate probably had greater impact than around constrained nucleated settlements located within long-settled lowlands. This is especially the case because the Bronze Age phase of nucleated tell-type settlement developed on silt-clay plains that generally were less susceptible to erosion.

Unlike the phase of Iron Age settlement noted above, the Classical to Early Islamic phases of settlement frequently spread into the uplands of limestone, sandstone and basalt that appear, during the Bronze and Iron Ages, to have been under-settled marginal lands or pastures. Consequently, their impact on the environment was considerable. Not only did the extension of settlement apparently result in the acceleration of the removal of the woodland cover (Rosen 1997; Deckers and Riehl 2007), it also was associated with

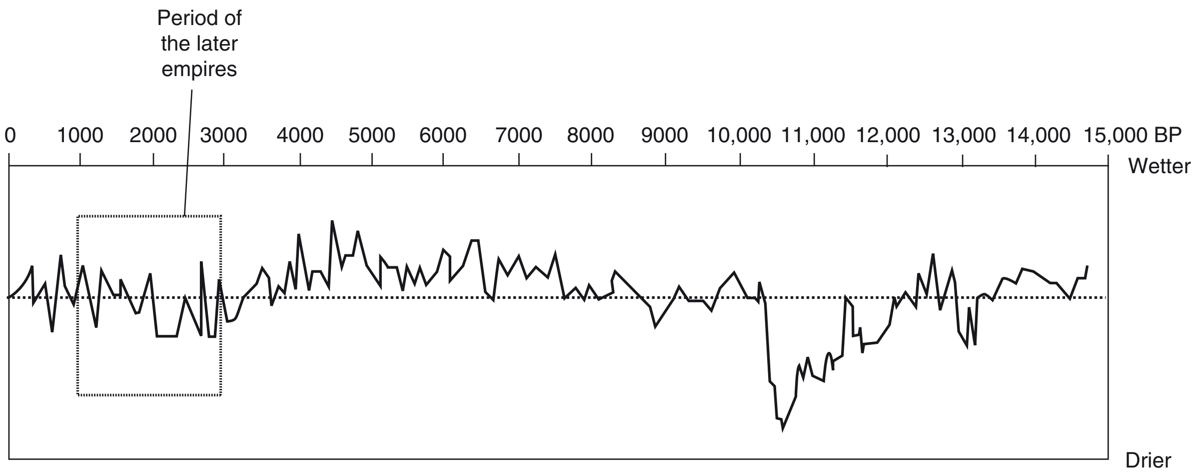
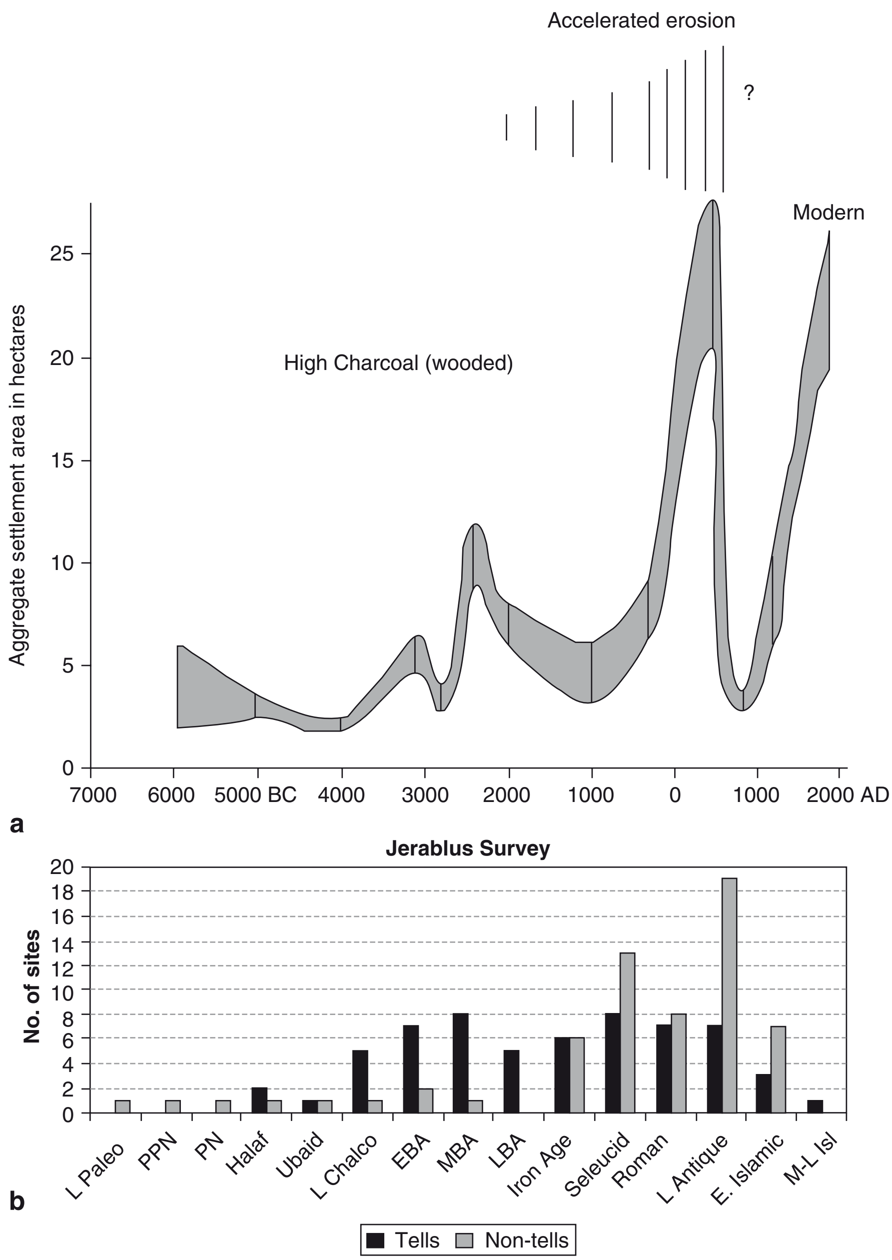


Fig. 9.3 Proxy isotopic record from Lake Van showing the moist phases (*above the dotted line*) and dry phases (*below*). The period of the later empires of the Iron Age and Roman-Byzantine period is indicated within the box. (After Lemcke and Sturm 1997)

Fig. 9.4 Long-term settlement curves. **a** Kurban Hoyuk area on the Turkish Euphrates. (After Wilkinson 1990) **b** Jerablus area near Carchemish: Note how the non-tells increase in number after the Iron Age



a phase of accelerated erosion and valley floor deposition that became widespread around the eastern Mediterranean.

Thanks to diversification of the local geography, the extension of settlement varied from place to place. For example, in the area of Kurban Höyük (Turkey), Late Roman–Byzantine settlement colonized all available landscape niches, namely the lower Euphrates Valley that was the long term locus of settlement, the episodically settled upper terrace, as well as the higher ridges beyond, the latter becoming pastures equipped with animal pounds and associated features. Around Jerablus in northern Syria, non-mounded but often spatially extensive settlements of short duration, occupied the river valleys between the long-settled tells, extending up previously uninhabited wadis and also settling the limestone uplands that comprised the interfluves between the main long-settled wadis (Fig. 9.4b). In addition, the uplands were also the locus of stone quarrying which occurred not only near the settlements, but again extended on to the uplands, areas that under previous settlement regimes must have been upland pastures presumably held in some form of common arrangement by local communities based in the main valleys.

At the same time, as settlement dispersal occurred, the river valleys became partly infilled with sedimentary accumulations that included post-Roman colluvia and thick deposits of high-energy alluvial deposits. Thus along the River Amarna, near Jerablus, a 2.5 m thickness of alternating beds of colluvia, and weakly developed paleosols overlay channel gravels of the river, whereas in the nearby Wadi Seraisat, thick cobble and gravel beds of high-energy channels planed across and destroyed a pre-existing Roman–Byzantine industrial area (Fig. 9.5a, b). In the Kurban Höyük area, the best examples of landscape degradation associated with settlement extension took the form of the rapid growth of alluvial fans. Although these were apparently initiated at the beginning of the second millennium BC following a local settlement peak of the early Bronze Age date, arguably they attained their maximum extent during the Late Roman and Byzantine phases when erosion had eventually bitten into the chalky bedrock and deposited an upper alluvial fan fill (Wilkinson 1999). Overall, it is common to find Hellenistic, Roman, and Byzantine buildings or other

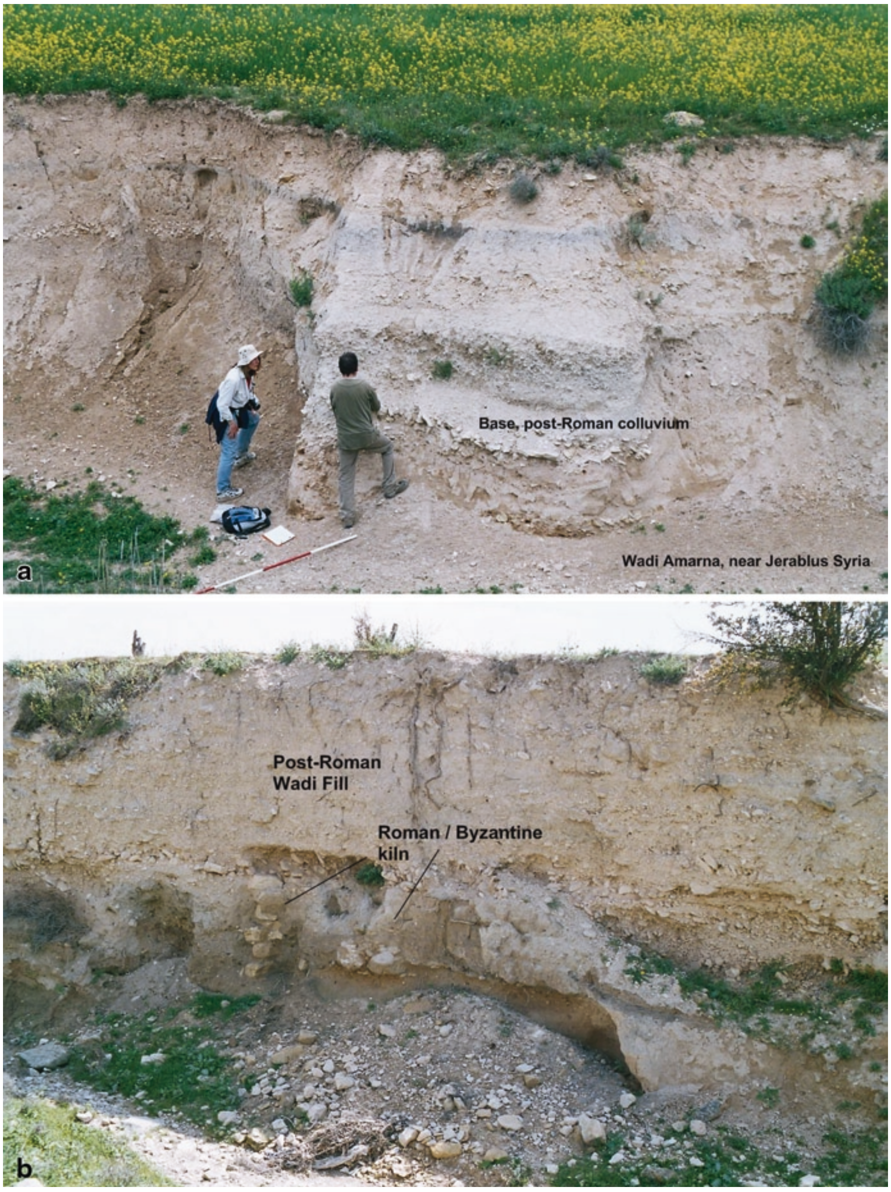


Fig. 9.5 **a** A colluvial/alluvial sequence on the south bank of the Amarna River south of Carchemish in Syria. Sediments above the figures' heads are dated to the post-Byzantine period. **b** High-energy wadi gravels overlying Late Roman/Byzantine kilns in the Wadi Seraisat south of Carchemish, Syria

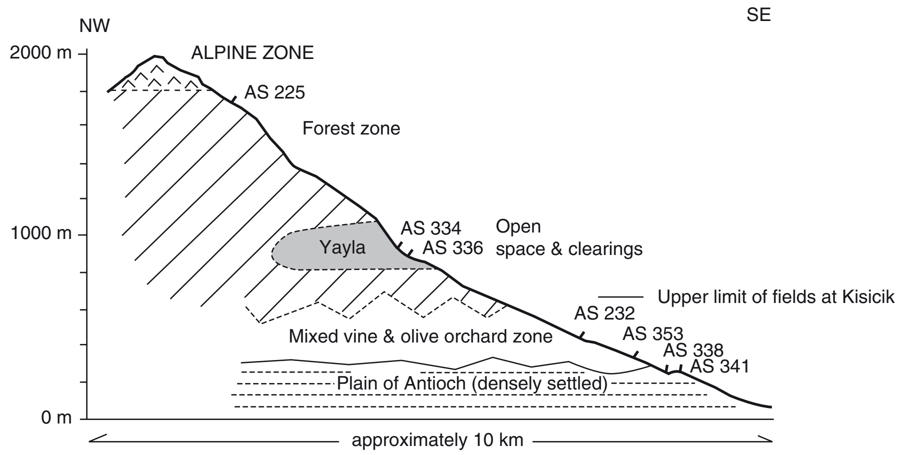


Fig. 9.6 Settlement zones inferred for the Amanus Mountains during the Roman/Byzantine period

structures sealed below thick accumulations of colluvial, alluvial fan or alluvial deposits, examples having been found in the western Amuq Valley (Casana and Wilkinson 2005), the Cilician coast (Beach and Luzzadder-Beach 2008), the Jebel al-Aqra, near the Amuq (Casana 2008), along the Syrian Euphrates near Meskene (Harper 1975), as well as in numerous locations around the Mediterranean (Vita-Finzi 1969).

Further west, the so-called Massif Calcaire to the NW of Aleppo, provides the clearest indication of settlement encroachment on to the uplands. In this area of denuded limestone uplands, some 700 villages and monastic communities remain today as upstanding remains of one of the most remarkable ancient landscapes of the Middle East. Settlements are surrounded by their relict fields and track-ways to form a relatively brief phase of cultural landscape that was initiated during the Seleucid Empire, but reached its climax during the eastern Roman–Byzantine Empire between the fourth and sixth centuries AD (Tchalenko 1953; Tate 1992). Although no geoarchaeological studies have been published for the best known part of this terrain, neighboring areas in southern Turkey, which show a more subtle manifestation of the same process, demonstrate that the extension of settlement into the uplands was associated with erosion of the same uplands and the complementary accumulation of colluvial fills, growth of alluvial fans and valley floor alluviation (Casana and Wilkinson 2005; Casana 2008). This area, which fell within the immediate hinterland of Antioch, experienced the spread of a rash of minor settlements into erodable sandstone and shale uplands south east of the main city, on to limestone uplands further to the east, and to elevations of 1000 m above sea level in the Amanus Mountains in the north (Fig. 9.6). In the Amanus Mountains this upper extension of settlement was probably associated with vine and olive husbandry which is still practiced up to similar elevations today. Most of these settlements appear to have been the farmsteads of individual households or small villages. Nevertheless, the existence of temples on hill tops and mining settlements within the metalliferous zone of the Amanus Mountains demonstrate that both secular and religious activities must have contributed to the loss of vegetation and soil cover. In the most vulnerable areas of sandstone and shale, Casana has demonstrated that massive aggradation can result where settlement extended rapidly into what had previously been wooded uplands. The resultant erosion resulted in a burst of aggradation in the local valleys that ranged from 12 to 30 times the long-term mean for the region (Casana 2008). On the other hand the encroachment of settlement into the nearby Amanus Mountains appears to have resulted in the growth of alluvial fans in the neighboring lowlands (Casana and Wilkinson 2005). Similar aggradation is also evident in Cilicia, in the vicinity of Kinet Höyük, where some 1.0–5.0 m of post-Hellenistic aggradation has been recorded. This included 1.00 and 1.8 m of aggradation over successive re-buildings of Roman roads (Beach and Luzzadder-Beach 2008). As in the Jebel al-Aqra area, rates of sediment aggradation peaked during the later empires and between the Hellenistic and Later Roman periods accumulation rates were 2.5 times greater than both before or after this period (Beach and Luzzadder-Beach 2008).

However, probably the most integrated record of settlement and landscape impacts derives from the

Taurus Mountains of western Turkey, where Waelkens and colleagues (Vermoere et al. 2000) have used multi-proxy records of settlement, biotic indicators and geo-archaeology to demonstrate that settlement growth, woodland clearance, fire-induced erosion and accumulation of valley fills all coincided to form a single horizon, the Beyşehir Occupation Phase. Broadly dated between 3265 and 1300 BP, this horizon includes much more specific events of fire impacts between 2320 and 1820 cal year BP (Kaniewski et al. 2008).

9.3 Case Studies: The Extension of Settlement into Climatically Marginal Areas

Because the later empires were powerful polities that exercised their administrative clout over large areas, and often moved entire communities from place to place, the relationship of empires to the environment was often different from that of earlier political regimes. In some cases, colonization of land extended into the semi-desert or uplands on to terrain that would have been regarded as environmentally marginal by earlier regimes. Colonization often apparently disregarded the limitations of such environments.

Written sources from the Ottoman Empire demonstrate that settlement processes in climatically marginal areas were complex and often did not simply consist of the colonization of marginal areas during moister intervals and retreat during dry spells. Rather, Norman Lewis has demonstrated that during the eighteenth and nineteenth centuries AD, settlement in Syria and Jordan depended mainly upon the administrative strength of the Ottoman Empire (Lewis 1987). During times of weakness, or when the local administrative apparatus of the empire was weak, Bedouin tribes from the deserts became the scourge of the marginal lands, even threatening the city of Aleppo. At other times, under strengthened administrations, the area witnessed the sedentarization of Bedouin tribes, or optimum relations between the sedentary and mobile communities. Although this may not be the entire story, again it indicates that even in areas where rainfall was crucial for successful agriculture, in sub-marginal areas where agriculture is possible, human administrative factors can lead to areas of high settlement potential becoming deserted.

The Neo-Assyrian Empire expanded into the climatically marginal steppe of the Jazira of northern Syria, an area that had been sparsely populated during the Late Bronze Age and Early Iron Age. On the other hand, under the later Roman empires in the deserts and uplands of the Levant, there was conspicuous settlement expansion under conditions of economic growth (Rosen 2007).

Perhaps one of the best documented examples of such settlement expansion into climatically marginal areas comes from central Syria where the record for the later empires is, however, just one of a series of settlement cycles. These start with sparse Pre-Pottery Neolithic B (PPNB) occupation followed by a retreat or even absence of settlement during the Halaf, Ubaid and Late Chalcolithic settlement (Fig. 9.7, ca. 6500 BP). There followed a rapid expansion of settlement during the Early Bronze Age, which reached some 57 km east of the Chalcolithic limit during Early Bronze IV (Fig. 9.7, ca. 4300 BP). After this there was a thinning of population during the Middle Bronze Age, and virtually a desertion during the Late Bronze Age, as settlement retreated towards the long-settled lands in the west. During the Iron Age (ca. 3000–2600 BP) settlement continued to be confined primarily to the west, a situation that contrasted with that between the Tigris and Euphrates where the Iron Age witnessed colonization and the establishment of settlement schemes. At this time, central Syria showed minimal evidence for sedentary occupation (Geyer and Rousset 2001; Geyer et al. 2007), probably because it was the domain of Aramaean and affiliated mobile groups and was beyond the effective reach of Neo-Assyrian imperial policy. By the Hellenistic period (starting in the third century BC) there commenced a rapid extension of settlement eastwards with settlement extending 15, 47, and 87 km east of the Chalcolithic minimum in the Hellenistic (2300 BP), Roman (2000 BP) and Byzantine (1500 BP) periods respectively (Geyer et al. 2007). After this, there followed progressive retreat through the early Islamic, Ayyubid and Mamluk periods until the recovery of settlement during the Ottoman revival of the seventeenth and eighteenth centuries and the twentieth century AD.

Although, it has been suggested that the dramatic Roman-Byzantine expansion of settlement occurred during a period when the climate was relatively favorable to agriculture (Geyer and Rousset 2001), the isotopic proxy records from Soreq Cave (Israel) and Lake

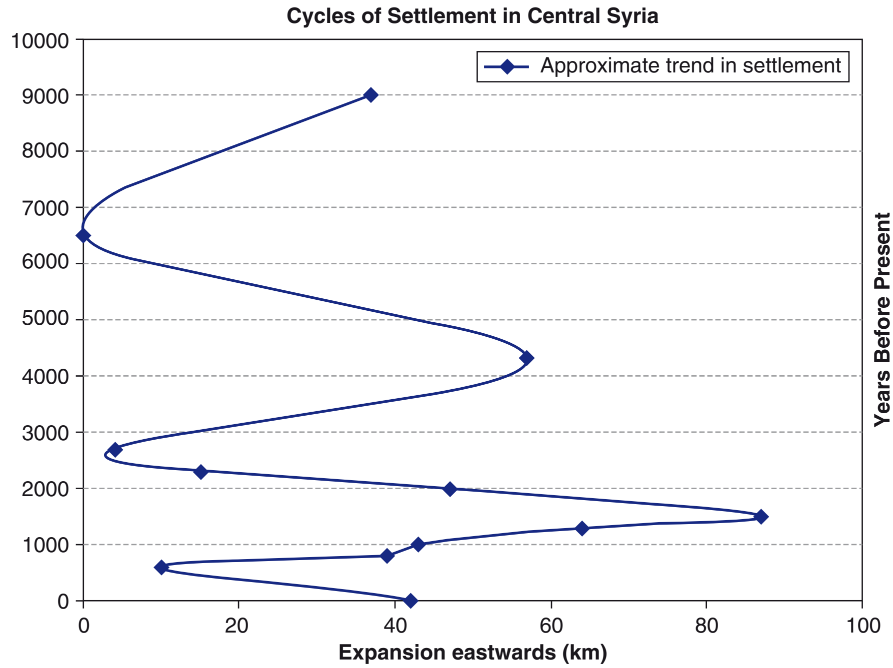


Fig. 9.7 Diagram showing cycles of settlement expansion and decline in central Syria. (After Geyer and Rousset 2001)

Van (Turkey), indicate the climate was rather drier than obtained during the Chalcolithic and Early Bronze Age. More significantly, during these six to eight centuries, the isotopic records indicate that climate varied around present day levels with both wetter and drier conditions prevailing (Fig. 9.3). In other words, there was no single wetting trend that could account for such colonization, although there were wetter phases when agricultural production would have been more successful. A similar point has been made by Arlene Rosen for the southern Levant, but using the climate proxy curve from Soreq Cave (Rosen 2007). For this period of territorial empires such settlement would have been encouraged within a relatively secure imperial administration, so that any shortfalls in production could be (within reason) met by the wider network of supply that prevailed (Rosen 2007), and most important, any climatic limitations could be overridden by hydraulic technology. Although this administrative hold was relatively light or absent during the Seleucid Empire, by the Roman period the extension of settlement was contained within and west of the Roman frontier system and the frontier road, the 'Strata Diocletiana' which ran from Damascus to Palmyra (Tadmor), and then Resafa, reaching the Euphrates near Sura. The emplacement of a Roman military frontier with military roads and forts was associated with a long step-by-step advance of the Roman military presence and a settled population into the dry steppe (Millar 1993). That protection from the Saracens ('bedu') was part of this programme is emphasized by inscriptions that record the construction of reservoirs in the Jordanian steppe to afford protection to the population away from the Saracens (Millar 1993). Within central Syria, although the *Pax Romana*, may have contributed the overall administrative framework, in reality, on the ground many of the settlements had semitic, that is local names and were under the administration of local governors and/or cities such as Palmyra (in the desert), Andarin (in the steppe), and Apamea (in the verdant west; Millar 1993; Butcher 2003).

Significant settlement expansion in the fourth century AD may have been encouraged by the reorganization of the Roman tax system under Diocletian, and yet further by Constantine who provided tax incentives for military veterans who farmed otherwise deserted lands (Butcher 2003). By the Byzantine period, in the fifth and sixth centuries AD, it is clear that settlement extension occurred both under the administration of a territorial empire as well as under conditions where more sophisticated water systems were being developed and built, specifically 'qanats' (underground irrigatin canals), wells, and cisterns (Geyer et al. 2007). Settlement expansion in central Syria was especially associated with the construction of major systems of 'qanat Romani' (Lightfoot 1996; Geyer and Rousset

2001), and their attendant monumental cisterns which not only enabled the land to be cultivated, but even enabled communities such as that at the town of Andarin (ancient Androna) to farm fish (Mango 2002).

Although subject to crises of drought, cold and plague, the climate of the fourth to sixth centuries AD was little different from that of the present day, and certainly was drier than during the optimum conditions of the sixth, fifth, and fourth millennia BC, when settlement was either rare, or limited to very few sites. Perhaps what is most telling about the cycles of expansion and contraction of settlements that occur in this region is how little they correlated with phases of wetter and drier conditions. In fact, for the southern Levant the later empires were in place during a period of less variable climatic conditions (Rosen 2007), although such stability is less evident in the Lake Van curve (Fig. 9.3).

9.4 Case Studies: Water Supply and the Spread of Irrigation Technologies

A key factor that enabled territorial expansion to take place into the marginal lands of empires was the adoption of hydraulic systems for irrigation and water supply which were harnessed to over-ride any environmental limitations. These technologies, which had been developed during the Neo-Assyrian Empire and earlier, were refined and elaborated during the later empires and not only enabled dry-lands to be colonized, but also contributed to increased agricultural productivity in climatically marginal areas. Such developments also resulted in changes in the hydrological regimes of rivers, or even their diversion.

During the expansive later territorial empires, administrative control extended over large areas, either directly or via local governors or city administrations. This enabled larger and longer systems of water supply to be constructed with the result that the Middle East witnessed the rapid expansion of irrigation systems and their associated settlements over areas that, hitherto, had been only sparsely settled. This is particularly evident in the zone that separates irrigated southern Mesopotamia from the rain-fed northern regions of upper Mesopotamia. Here large areas of land were settled (Fig. 9.1): to the west of the Tigris near Samarra (Adams 1972); along the lower Khabur River (Ergenzinger et al. 1988); along the lower Balikh in Syria (Wilkinson 1998); in the Euphrates valley south of Jerablus (Carchemish) on the Turkish border (Wilkinson et al. 2007).

The withdrawal of substantial amounts of water from rivers for irrigation appears to have had significant impacts on the discharge of some of the Euphrates tributaries. This was especially apparent along the modest sized Balikh River whose discharge of around $6\,m^3/sec$ ($=15.77$ million $m^3/month$) appears to have been significantly depleted by the withdrawal of water (Kolars and Mitchell 1991; Wilkinson 1998). Textual records indicate that there was some degree of water competition between upstream and downstream communities during the second millennium BC (Dossin 1974; Villard 1987). By the late first millennium BC and early first millennium AD when canals up to 6 m wide were in operation, sections through paleochannels of the Balikh demonstrate a progressive diminution of flow through the first millennia BC and AD (Wilkinson 1998). Similar levels of abstraction probably occurred along the Khabur River in NE Syria where large canal systems were in use from probably the first millennium BC (Ergenzinger et al. 1988; Morandi Bonacassi 2000), as well as along the west bank tributary of the River Amarna near Carchemish where Roman–Byzantine conduits appear to have replaced an earlier earthen canal (Wilkinson et al. 2007).

Not only did the abstraction of river waters for irrigation result in depletion of river flow, but also the discharge of excess water from the downstream (outfall) ends of canals and irrigation systems frequently contributed to the development of marshes. This process has been well documented for southern Mesopotamia where cuneiform texts, Islamic histories and archaeological surveys indicate the formation of marshes during the Neo-Babylonian, Sasanian, and early Islamic empires. Such inundation appears to have developed, in part, as a result of the excess outflow of irrigation waters into large sumps or flood basins, the deterioration of canals, major floods or even deliberate human river diversion (Cole 1994; Adams 1981).

Such processes also had significant impacts on the local environment in NW Syria and southern Turkey where extensive marshes and shallow lakes developed during the late first millennium BC and first millennium AD (Wilkinson 1997; Casana 2004; Eger 2008b). The history of the lake of Antioch within the Amuq Valley of southern Turkey is not known in detail, but

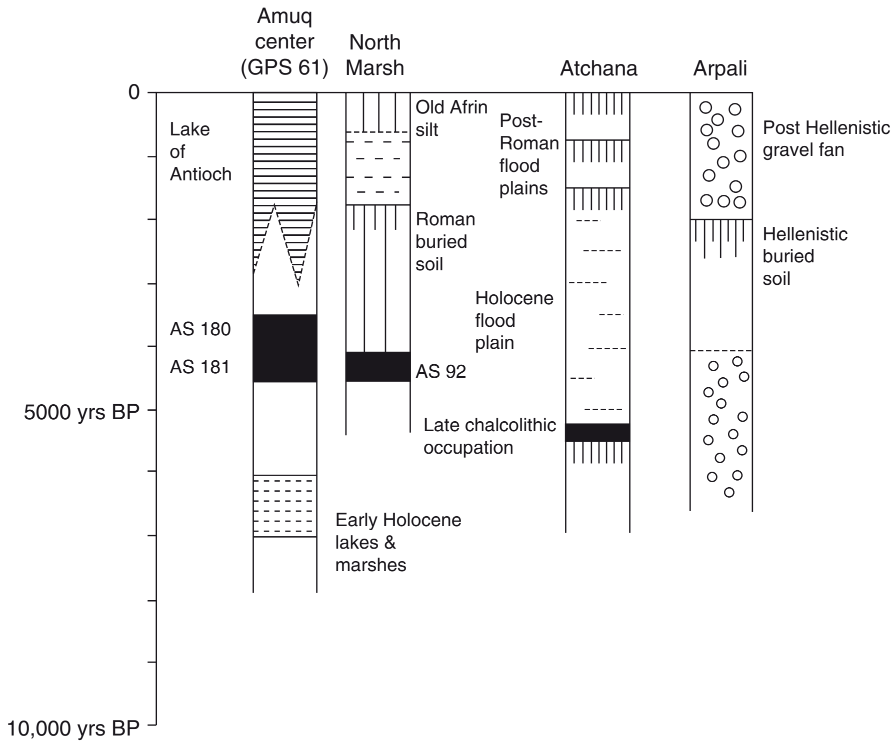


Fig. 9.8 Sections through the Amuq Plain showing lake beds, alluvial and fan deposits in relation to buried settlement horizons. (After Yener et al. 2000)

it is clearly post Bronze Age in date (Fig. 9.8). According to the Late Roman writers Libanius and Malalas, a lake was present in the early centuries AD and appears to have further expanded in early Islamic times (Eger 2008a). Ceramics on the associated sites date the construction of canals to the early Islamic period (seventh and early eighth centuries AD, Eger 2008a, b), at which time the lake and its reed-fringed marshes appear to have expanded eastwards. Two major canal systems diverted flow off the Afrin River and were used to supply settlements and presumably their irrigation systems with water in the eastern plains. Although it is likely that no single factor contributed to the expansion of the Amuq Lake and its marshes, it appears that a combination of accelerated deposition in the Amuq, flooding and perhaps avulsion of rivers, increased runoff from the surrounding uplands, and the outfall of excess irrigation water from canals contributed to the development and growth of the lakes and marshes (Wilkinson 1997; Casana 2004; Eger 2008a; Gerritsen et al. 2008). Overall, these canals not only reduced the flow of the ancient Afrin River, but also diverted some of that flow into marshes, thereby transforming a riverine plain drained by a vigorous trunk river into a plain drained by a diminished river with extensive marshes.

Elsewhere, however, other marshes shrunk during the late Roman period. For example the Berekat marsh in the western Taurus Mountains of Turkey was reduced as a result of the increased discharge of sediment from neighboring slopes caused by succession of fire events (Kaniewski et al. 2008).

Because the construction of canal off-takes introduced weaknesses into river banks and levees, it appears that in lowland Mesopotamia and southwest Iran, the entire flow of rivers could be diverted along canals. A well-documented recent avulsion has been recorded to the SW of Baghdad where during the final stages of Ottoman administration, the Euphrates started to flow along a canal, the Hindiyeh branch, leaving the Hilla branch of the river empty (Cadoux 1906; Gibson 1972). Despite the best efforts of the Turkish government to construct a barrage, this only diverted 1/3 of the flow back down the Hilla branch so that the flow down the Hindiyeh branch predominated. Then in 1903 the barrage broke leaving the Hilla branch dry so that the entire flow adopted the Hindiyeh branch. In terms of human impacts on the environment, it is significant that what is frequently regarded as a natural process, namely avulsion, in this case resulted from a major river adopting a canal (Hindiyeh branch) for its course. This then led Cadoux to suggest that the Shatt al-Gharraf in the southern plains of Mesopotamia was also originally a canal, before it became a branch of the Tigris. Cadoux also blamed the increased diversion of water into irrigation canals, as well as the presence of temporary dams for water diversion, for the increased amount of sedimentation within the channels. By providing alternative flow paths for the rivers and trapping sediment that tended to clog the flow, these two factors contributed to the tendency of the channel to shift to a more advantageous course (Cadoux 1906).

A particularly good historical example of the role of human agency in the diversion of rivers is provided by the Gargar River in Khuzestan, SW Iran, where a canal appears to have initiated a major river avulsion. According to Islamic geographers, a massive gorge was dug at Shushtar under the administration of the Sasanian King Chosroe. Later this canal adopted many of the flow characteristics of a natural river, such as sinuosity and fluvial terraces, a situation which prevails to the present day. This diversion, which is attested by both geoarchaeological investigations and early Islamic geographers (Alizadeh et al. 2004; Moghaddam and Miri 2007) not only resulted in a massive diversion of the waters of the Karun River, but also initiated a phase of landscape incision and badland development that itself exhumed a prehistoric archaeological landscape along the east bank of the Gargar River. Similarly along the Tigris River, the adoption of a more easterly course for the Tigris near Samarra, arguably represents the avulsion of much of the river's flow along a series of canals dug to capture irrigation water during the Sasanian and early Islamic empires (Adams 1965; Northedge et al. 1990).

9.5 Discussion

Because archaeology, and indeed the ancient world, is often subdivided into chronological specialties such as Assyriology, Classics, Roman, Byzantine, and so on, there has been a tendency to ignore the broad trends in settlement that prevail over longer periods of time. Instead scholars tend to compare relatively brief slices of contiguous time, over which the broad trends are hardly visible. In reality, it is over cycles such as the Early Bronze Age to Roman or Byzantine periods that truly significant changes in the landscape are evident. Despite this relative myopia, one of the key trends in Near Eastern Settlement has not escaped Roman archaeologists: "In the midst of all this uncertainty one rural trend is absolutely clear. During the period of Roman rule the settled rural population increased enormously in Syria and the Near East. Good land was densely settled, and marginal lands such as the dry steppe or stony highlands were occupied more intensively than at any time before." (Butcher 2003, p. 140).

As argued above, the phase of Roman settlement was just part of a broader trend that started with the Neo-Assyrian Empire and continued at least in places into the Abbasid Caliphate. Nevertheless it should not be assumed that empires were uniform entities with consistent administration. They were usually composed of a mosaic of provinces and cities, together with client states and other buffer states beyond (Butcher 2003) and the patterns of landholding and rural settlement within them must have been equally complex. In the Byzantine Empire, estates and other forms of extensive land holdings grew and developed in association with the church and monastic communities (Ward-Perkins 2000). On the other hand at the village level of organization, the patterns of Roman and Byzantine rural settlement in areas such as Kurban Höyük in Turkey did not develop within the core of imperial settlement but rather were administratively located within Osroehene, a small province that was not established until 194 or 195 AD (Wilkinson 1990; Butcher 2003).

If the political administration of the later empires was complex, the associated human-environment interactions were even more so, and included (at risk of oversimplification) such as extension of settlement into climatically marginal zones and uplands; associated loss of tree cover; increased erosion and associated valley floor aggradation; the spread of irrigation technologies; depletion of river discharges by diversion of water into canals; canal construction combined with high flood peaks resulted in avulsion and diversion of river channels, especially in lowland riverine plains; the inadvertent but sometimes deliberate creation of swamps and marshes as a by-product of the construction of canals; and the diminution of marshes as a result of the accumulation of eroded sediments.

In addition, landscape degradation in upland basins exacerbated flood levels downstream and the loss of forest cover may have contributed a feedback affect to local climates and atmospheric circulation. When combined, the extension of settlement into marginal lands, loss of tree cover, enhanced runoff and abstraction of water for irrigation all appear to have increased peak flood discharges and lowered the dry season flows. Together these contributed to increased variations of stream discharge and more flashy flow regimes.

In the NW Levant, the dispersal of villages and farmsteads away from pre-existing tells frequently resulted in terrain that had previously been fairly stable under less erosive regimes becoming eroded. This contributed increasing amounts of sediment to the lowlands as valley fills. Each area, however, was affected by these processes differently. Roman-Byzantine settlement along the Turkish Euphrates included the extension of hamlets and farmsteads onto higher river terraces, whereas around the Amuq Valley such extension occurred into the Amanus Mountains or the readily eroded hills south of Antioch. In NW Syria and near Carchemish, extension occurred into the limestone hills which appear to have been partially stripped of their soil cover, whereas in central Syria, the equivalent settlement was into climatically marginal areas of semi-desert. In contrast, for the earlier Neo-Assyrian expansion, most settlement infilled the voids between pre-existing lowland settlements, although around Tell Beydar this did include settlement on to low interfluves and basaltic uplands. In addition, occasional forts that were constructed on low hills represented a minor extension on to higher land, but settlement expansion into the uplands was never as pervasive as during the Roman-Byzantine periods.

Significantly, landscape degradation was not simply caused by local population pressure or for the satisfaction of local needs. Rather, erosion was caused by the demands of the greater empire, so that erosion in one area reflected the demand for economic crops and products either in distant locations or within the core of empires. This is best exemplified by the massive increase in the demand for olive oil around the greater Mediterranean that stimulated the growth of orchards and settlement in the uplands of the NW Levant (Mattingly 1996; Ward-Perkins 2000). In addition, the presence of monastic communities and centers of pilgrimage at sites such as Qalat Siman northwest of Aleppo demonstrate that expansion was not simply a result of economic growth; rather religion and economic growth were intertwined. Although many features of the spatial economy of the Roman and Byzantine empires continue to be debated, as Chew (2001) has argued for the development of World System economies, landscape degradation is often exported as a result of needs in one part of a trading or administrative system being met by production elsewhere.

Such settlement (and associated erosion) did not simply occur under the macroscopic conditions that prevailed when imperial powers were able to effectively control or administer vast areas. They were also scaled down through a hierarchical system of human action that prevailed under such empires. At the level of the individual, land holdings that had previously been held by a corporate group or community for episodic pasture, might have been regarded by the imperial powers as underused or deserted. As a result peasants farming that land and maintaining its productivity would have been granted ownership (Butcher 2003), with the result that episodic pasture or forage land would have shifted to cultivation with a significant increase of sediment yield and soil erosion. This settlement and the associated landscape degradation appear to have had their origins in a number of factors that include extension of private land holdings into what presumably have been common property, allocation of land to veterans under Roman administration, growth of intensive agriculture around growing urban areas (Casana 2003), settlement within estates, or forced displacements of populations from other regions. In addition, the spread of technologies such as iron tools, which was easier when vast areas were controlled by a single administration, may also have contributed to the extension of cultivated land use. When the new farmers were drawn from non-local populations, they would have lacked an intimate knowledge of the local soils, with the result that landscape degradation may have been exacerbated by inappropriate husbandry practices. All such processes of land allocation appear to have contributed to this phase of settlement and its associated degradation.

In the Jerablus, Amuq, Biqa, and upper Euphrates areas, estimates of aggregate settlement area suggests that there was a significant population increase during the Roman-Byzantine empires, and this combined with the expansion of settlement on to erodable uplands and the abstraction of water from the main wadis resulted in the increased accumulation of valley fills and more flashy flow conditions. Such circumstances appear to have been exacerbated by the diversion of outflow water from canals into former flood basins that subsequently became persistent marshes or lakes.

Human activities and population extension under growing territorial empires indeed provide a compelling cause for increased soil erosion and degradation, over and above the levels that would have been expected under the prevailing natural regime. Nevertheless, by focusing on cultural process, the above discussion may give the impression that the aggressive spread of human settlement and cultural landscapes was the only force driving soil erosion and accelerated aggradation. This is not the case, however, because the spread of human activity may simply have created the pre-conditions for soil erosion in the form of bare land and conditions favorable for increased runoff. Consequently, when storms or deluges occurred, the resultant degradation would have been greater than before such activity (Casana 2008; Bintliff 2002; Grove and Rackham 2001). Whether such erosion coincided with a period of extension of cultivation and increased rainfall or simply took place under normal rainfall conditions is unclear. Although long-term proxy records such as that from Saroq Cave in Israel suggest there was no obvious increase in rainfall during the phase of erosion in the Amuq, or indeed elsewhere in the Near East during the later empires, our climate sources are not sufficiently high resolution for us to be certain (Casana 2008).

In conclusion, the relationship between human action and the environment during the later empires was a tangled one. Not only did individual humans, provincial and city administrations, as well as imperial rulers, initiate significant amounts of settlement that triggered erosion and aggradation, they also had a significant impact on certain proxy indicators of environmental change by diminishing river flow or by creating marshes. In addition, the widespread adoption of technologies of water distribution in marginal or sub-optimal areas enabled dry climatic cycles to be over-ridden, or for locally verdant but geographically remote environments to be utilized for cultivation for the first time. Moreover, by extending their reach into climatically marginal lands, imperial administrations may have enabled the maximum opportunity to be taken of short-lived moist phases. In addition, the increased impact of humans on the landscape itself changed the impact of weather and climate on the land. Although such inter-relations may appear bewilderingly complex, the careful reading of historical records, geoarchaeological evidence, proxy climate records and archaeological surveys demonstrates that the individual strands of such inter-relationships can be unravelled to produce a more nuanced understanding of past landscape change.

Acknowledgements Many thanks to Claudio Vita-Finzi and John Bintliff for discussions at various times on this subject.

References

Adams R Mc (1965) Land behind Baghdad. University of Chicago Press, Chicago, 187 pp

Adams R Mc (1972) Settlement and irrigation patterns in ancient Akkad. In: Gibson McG (ed) The city and area of Kish. Field Research Projects, Miami, pp 182–208

Adams R Mc (1981) Heartland of cities. University of Chicago Press, Chicago, 362 pp

Alizadeh A, Kouchoukos N, Wilkinson, TJ, et al. (2004) Human-environment interactions on the Upper Khuzestan Plains, southwest Iran. Recent investigations. PaleOrient 30:69–88

Beach TP, Luzzadder-Beach S (2008) Geoarchaeology and aggradation around Kinet Höyük, an archaeological mound in the Eastern Mediterranean, Turkey. Geomorphology 101:416–428

Bernbeck R (1993) Steppe als Kulturlandschaft. Dietrich Reimer, Berlin, 210 pp

Bintliff J (1992) Erosion in the Mediterranean lands: a reconsideration of pattern, process and methodology. In: Bell M, Boardman J (eds) Past and present soil erosion. Archaeological and Geographical Perspectives, Oxbow Books, Oxford, pp 125–31

Bintliff J (2002) Time, process and catastrophe in the study of Mediterranean alluvial history: a review. World Archaeology 33:417–435

Brückner H (1986) Man's impact on the evolution of the physical environment in the Mediterranean region in historical times. GeoJournal 13:7–17

Butcher K (2003) Roman Syria and the Near East. British Museum Press, London, 472 pp

Butzer KW (1964) Environment and archaeology. An introduction to Pleistocene Geography. Aldine, Chicago, 524 pp

Cadoux HW (1906) Recent changes in the course of the lower Euphrates. Geographical Journal 28:266–77

Casana JJ (2003) From Alalakh to Antioch: settlement, land use and environmental change in the Amuq Valley of Southern Turkey. PhD. Dissertation, NELC, University of Chicago

Casana JJ (2004) The archaeological landscape of Late Roman Antioch. In: Sandwell I, Huskinson J (eds) Culture and society in Late Roman Antioch, Oxbow, Oxford, pp 102–25

Casana, JJ (2008) Mediterranean valleys revisited: linking soil erosion, land use and climate variability in the Northern Levant. Geomorphology 101:429–442

Casana JJ, Wilkinson TJ (2005) Settlement and landscapes in the Amuq Region. In: Yener KA (ed) The archaeology of the Amuq Plain. Oriental Institute Publications 131, Chicago, 25–65 and 203–280

Chew SC (2001) World ecological degradation: Accumulation, urbanization and deforestation 3000 BC–AD 2000. Alta Mira, Lanham, New York, 217 pp
Cole SW (1994) Marsh formation in the Borsippa region and the course of the lower Euphrates. Journal of Near Eastern Studies 53:81–109
Cordova C (2000) Geomorphological evidence of intense prehistoric soil erosion in the highlands of central Jordan. Physical Geography 21:538–567
Deckers K, Riehl S (2007) Fluvial environmental contexts for archaeological sites in the Upper Khabur basin (northeastern Syria). Quaternary Research 67:337–348
Dossin G (1974) Le site de Tuttul-sur-Balikh. Revue Assyriologique 68:25–34
Doyle MW (1986) Empires. Cornell University Press, Ithaca, 407 pp
Eger A (2008a) The spaces between the teeth. Environment, settlement and interaction on the Islamic-Byzantine frontier. PhD dissertation, NELC, University of Chicago, 567 pp
Eger A (2008b) The early Islamic period (mid 7th to mid 10th centuries). In: Gerritsen F, De Giorgi A, Eger A, et al. (eds) Settlement and landscape transformations in the Amuq Valley, Hatay. A Long-term perspective. Anatolica 34:267–274
Ergenzinger PJ, Frey W, Kühne H, Kurschner H (1988) The reconstruction of environment, irrigation and development of settlement on the Habur in North-east Syria. In: Bintliff J, Davidson DA, Grant EG (eds) Conceptual Issues in environmental archaeology, University Press, Edinburgh, pp 108–128
Gerritsen F, De Giorgi A, Eger A, et al. (2008) Settlement and landscape transformations in the Amuq Valley, Hatay. A Long-term perspective. Anatolica 34:241–314
Gerber C (1996) Die Umgebung des Lidar Höyük von Hellenistischer bis FrühIslamischer Zeit. In: Bartl K, Hauser SR (eds) Continuity and Change in Northern Mesopotamia from the Hellenistic to the Early Islamic Period. Dietrich Reimer, Berliner Beitrage zum Vorderen Orient Band 17, Berlin, pp 303–332
Geyer B, Rousset MO (2001) Les steppe arides de la Syrie du nord à l' époque Byzantine ou "la ruée vers l' est". In: Geyer B (ed), Conquête de la Steppe: et appropriation des terres sur les marges arides du Croissant fertile. Travaux de la Maison de l'Orient Méditerranéen no. 36, de Boccard, Paris, pp 111–121
Geyer B, al-Dbiyat M, Awad N, et al. (2007) The arid margins of Northern Syria: occupation of the land and modes of exploitation in the Bronze Age. In: Morandi Bonacossi D (ed) Urban and natural landscapes of an ancient Syrian capital. Settlement and environment at Tell Mishrefeh/Qatna and in central-western Syria. Studi Archeologici su Qatna 01. Forum, University of Udine, Italy, pp 269–281
Gibson M (1972) The city and area of Kish. Field Research Projects, Miami, Coconut Grove, 316 pp
Grove AT, Rackham O (2001) The nature of Mediterranean Europe. An ecological history. Yale University Press, New Haven, 384 pp
Goldberg P (1998) The changing landscape. In: Levy TE (ed) The archaeology of society in the Holy Land. Leicester University Press, Leicester UK, pp 40–57
Harper RP (1975) Excavations at Dibsi Faraj, northern Syria, 1972–1974: a preliminary note on the site and its monuments. Dumbarton Oaks Papers 29:319–338
Hole F, Kouchoukos N (in press) Preliminary report on an archaeological survey in the western Khabur basin, 1994. Annales Archéologiques Arabes Syriennes
Kaniewski D, Paulissen E, De Laet V, Waelkens M (2008) Late Holocene fire impact and post-fire regeneration from the Bereket basin, Taurus Mountains, southwest Turkey. Quaternary Research 70:228–239
Kolars JF, Mitchell WA (1991) The Euphrates River and SE Anatolia development project. Carbondale: Southern Illinois University Press, 390 pp
Larsen MT (1994) The conquest of Assyria. Excavations in an antique land 1840–1860. Routledge, London, 390 pp
Lemcke G, Sturm M (1997) ^{18}O and trace element measurements as proxy for the reconstruction of climate changes at Lake Van (Turkey): Preliminary results. In: Dalfes HN, Kukla G, Weiss H (eds) Third millennium BC climate change and Old World collapse. NATO ASI Series, Global Environmental Change 49. Springer, Berlin, pp 653–678
Lewis N (1987) Nomads and settlers in Syria and Jordan 1800–1980. Cambridge University Press, Cambridge, 268 pp
Lightfoot DR (1996) Syrian qanat Romani: history, ecology, abandonment. Journal of Arid Environments 33:321–336
Mango M (2002) Fishing in the desert. Palaeoslavica 10:323–330
Marfoe L (1979) The integrative transformation: patterns of sociopolitical organization in southern Syria. Bulletin of the American Schools of Oriental Research 234:1–42
Mattingly DJ (1996) First Fruit? The olive in the Roman world. In: Shipley G, Salmon J (eds) Human Landscapes in Classical Antiquity. Environment and Culture, Routledge, London, pp 213–253.
Millar F (1993) The Roman Near East 31–AD 337. Harvard University Press, Boston, 587 pp
Moghaddam A, Miri N (2007) Archaeological surveys in the "eastern corridor", south-western Iran. Iran 45:23–55
Morandi Bonacassi D (2000) The Syrian Jazireh in the Late Assyrian period: A view from the countryside. In: Bunnens G (ed), Essays on Syria in the Iron Age. Peeters Press, Louvain, pp 349–396
Mouterde R, Poidebard A (1945) Le Limes de Chalcis. Organisation de la steppe en Haute Syrie Romaine. Geuthner P, B.A.H. 38, Beyrouth-Paris
Northedge A, Wilkinson TJ, Falkner R (1990) Survey and excavations at Samarra. Iraq 52:121–148
Oates D (1968) Studies in the ancient history of northern Iraq. British Academy, London, 176
Oded B (1979) Mass deportations and deportees in the Neo-Assyrian Empire. Ludwig Reichert, Wiesbaden, 142 pp
Philip G, Jabour F, Beck A, (2002) Settlement and landscape development in the Homs region, Syria: research questions, preliminary results 1999-2000 and future potential. Levant 34:1–23
Radner K (2000) How did the Neo-Assyrian king perceive his land and resources. In: Jas R (ed), Rainfall and Agriculture in Northern Mesopotamia. Nederlands Historisch-Archaeologisch Instituut te Istanbul 88, Leiden, pp 233–246
Rosen AM (1986) Cities of Clay. The geoarchaeology of tells. University of Chicago Press, Chicago, 167 pp
Rosen AM (1997) The geoarchaeology of Holocene environments and land use at Kazane Höyük, S.E. Turkey. Geoarchaeology 12:395–416

Rosen AM (2007) Civilizing climate: Social responses to climate change in the ancient Near East. Alta Mira Press, Lanham, New York, 2007 pp
Tate G (1992) Les campagnes de la Syrie du Nord (Tome 1). Librairie Orientaliste Paul Geuthner, Paris, 364 pp
Tchalenko G (1953) Villages antique de la Syrie du Nord II. Vol 1. Librairie Orientaliste Paul Geuthner, Paris, 442 pp
Vermoere M, Smets E, Waelkens M, et al. (2000) Late Holocene environmental change and the record of human impact at Gravgaz near Sagalassos, Southwest Turkey. Journal of Archaeological Science 27:571–595
Villard P (1987) Un conflt d' autorités à propos des eaux du Balih. MARI 5:59–96
Vita-Finzi C (1969) The Mediterranean valleys: geological changes in historical times. Cambridge University Press, Cambridge, 140 pp
Ward-Perkins B (2000) Specialized production and exchange. In: Cameron A, Ward-Perkins B, Whitby M (eds) The Cambridge ancient history vol. XIV, Late Antiquity: empires and successors, A.D. 425–600. Cambridge University Press, Cambridge, pp 346–391
Wilkinson TJ (1990) Town and country in SE Anatolia vol.1: Settlement and land use at Kurban Hoyuk and other sites in the lower Karababa Basin. Oriental Institute Publications 109, Chicago, 315 pp
Wilkinson TJ (1995) Late-Assyrian settlement geography in Upper Mesopotamia. In: Liverani M (ed) Neo-Assyrian geography. University di Roma, Quarderni di Geografia Storica, 5, Rome, pp 139–159
Wilkinson TJ (1997) The history of the Lake of Antioch: A Preliminary note. In: Young G, Chavalas M, Averbeck R (eds), Crossing boundaries and linking horizons: Studies in honor of Michael C. Astour on His 80th Birthday. CDL Press, Bethesda, Maryland, pp 557–576
Wilkinson TJ (1998) Water and human settlement in the Balikh Valley, Syria: Investigations from 1992–1995. Journal of Field Archaeology 25:63–87
Wilkinson TJ (1999) Holocene valley fills of southern Turkey and NW Syria. Recent geoarchaeological contributions. Quaternary Science Reviews 18:555–572
Wilkinson TJ (2003) Archaeological landscapes of the Near East. University of Arizona Press, Tucson, Arizona, 260 pp
Wilkinson TJ, Barbanes E (2000) Settlement patterns in the Syrian Jazirah during the Iron Age. In: Guy Bunnens (ed) Essays on Syria in the Iron Age. Peeters Press, Louvain, pp 397–422
Wilkinson TJ, Wilkinson EB, Ur J, Altaweel M (2005) Landscape and settlement in the Neo-Assyrian Empire. Bulletin of the American Schools of Oriental Research 340:23–56
Wilkinson TJ, Peltenburg E, McCarthy A, et al. (2007) Archaeology in the land of Carchemish: landscape surveys in the area of Jerablus Tahtani, 2006. Levant 39:213–247
Yener KA, Edens C, Harrison TP, et al. (2000) The Amuq Valley Regional Project 1995–1998. American Journal of Archaeology 104:163–220