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Inhalt/Contents

Band I

Sektion Westlicher Mittelmeerraum/ Section Western Mediterranean

Band II

Sektion Mittel- und Osteuropa/ Section Central and Eastern Europe

Sektion Mitteldeutschland/ Section Central Germany

Sektion Nord- und Westeuropa/ Section Northern and Western Europe

Anhang/Appendix

Megadrought, collapse, and resilience in late 3rd millennium BC Mesopotamia

Harvey Weiss

Zusammenfassung

Massive Dürre, Zusammenbruch und Anpassungsfähigkeit im Mesopotamien des späten 3. Jts. v. Chr.

Die Abweichung bzw. Abschwächung der mediterranen Westwinde und des Indischen Monsuns zwischen 2200 v. Chr. und 1900 v. Chr. hatten eine gleichzeitige massive Dürreperiode im mediterranen Raum, in Westasien, am Indus und in Nordostafrika zur Folge. Trockenfeldbauregionen und deren Produktivität wurden massiv reduziert, was zu gesellschaftlichen Zusammenbrüchen und zum Verlassen gewisser Regionen, sowie zur Verlagerung von Lebensräumen und einer generellen Nomadisierung der Bevölkerung führte. Diese Verlagerung in Steppen-, Fluss-, Sumpf- und Karstquellenlandschaften in Westasien setzte eine hohe Anpassungsfähigkeit der Bevölkerung voraus und erlaubt es, bisher nur ungenügend bekannte Prozesse wie den Zusammenbruch des Akkadischen Reiches und andere regionale Phänomene des Zerfalls besser zu verstehen. Die Wiederkehr von Niederschlagsmengen um ca. 1900 v. Chr., die mit denjenigen vor der massiven Dürreperiode vergleichbar waren, ermöglichte es ehemaligen Nomaden, wieder sesshaft zu werden und leitete den Übergang zur mittelbronzezeitlichen Phase kriegführender Königreiche ein. Das dieser opportunistischen Wiederbesiedlung zugrunde liegende sozialen Gefüge bedarf jedoch noch weiterer Erforschung. Die hochauflösende Datierungs- und Transferfunktion der paläoklimatischen Proxydaten wird es der zukünftigen Forschung ermöglichen, den chronologischen Ablauf sowie das Ausmaß des Anpassungsverhaltens zu Beginn und am Ende der Dürreperiode genauer nachzuvollziehen.

Summary

The 2200–1900 BC (4.2–3.9 ka BP) deflection or weakening of the Mediterranean westerlies and the Indian monsoon generated synchronous megadrought across the Mediterranean, West Asia, the Indus, and north-east Africa. Dry farming agriculture domains and their productivity were reduced severely, forcing adaptive societal collapses and regional abandonments, habitat-tracking, and nomadisation. These processes extended across the steppic, riparian, paludal, and karst spring landscapes of West Asia, demonstrating demographic and societal resilience and illuminating previously obscure processes, such as collapse in the Akkadian Empire and adjacent regions. The return of pre-megadrought precipitation at c. 1900 BC permitted sedentarisation and resettlement by former pastoralists, and ushered in the succeeding Middle Bronze Age era of warring territorial kingdoms. However, the social forces behind the opportunistic resettlement remain to be explored. High-resolution dating and transfer functions for palaeoclimate proxy records will refine the understanding of the chronology and the magnitude of adaptive responses to the onset and termination of the megadrought.

Introduction

In West Asia and adjacent dry farming and irrigation-agriculture realms, adaptive social responses to altered dry farming cereal production developed within decades of the onset and terminus of the abrupt megadrought of 4.2–3.9 ka BP (4200–3900 years ago, or c. 2200–1900 BC). Relatively high-resolution and independent archaeological and palaeoclimate records document that this period of abrupt climate change began with: 1. political collapse and regional abandonments in rain-fed regions; 2. habitat-tracking to riparian, paludal, and karst spring-fed refugia where agriculture remained productive; and 3. nomadisation (subsistence-transfer from agriculture to pastoral nomadism). Adaptive social responses at the termination of the abrupt megadrought included: 1. sedentarisation and resettlement; 2. political state formation; 3. increased and enhanced surplus agro-production; and 4. political-territorial expansion.

These societal processes have previously been categorised archaeologically and historically in West Asia as components of the unexplained »Early Bronze/Middle Bronze transition«, »Intermediate Bronze Age«, »Akkadian collapse«, and »Amoritisation«. The highly resolved data currently available for the 4.2 ka BP abrupt megadrought have focused many palaeoclimate and archaeological research programmes on the period, while century-scale Holocene abrupt climate changes also occurred at 8.2 ka BP, (Weninger/Clare 2014), 5.2 ka BP (Staubwasser/Weiss 2006), and 3.2 ka BP (Kaniewski et al. 2013).

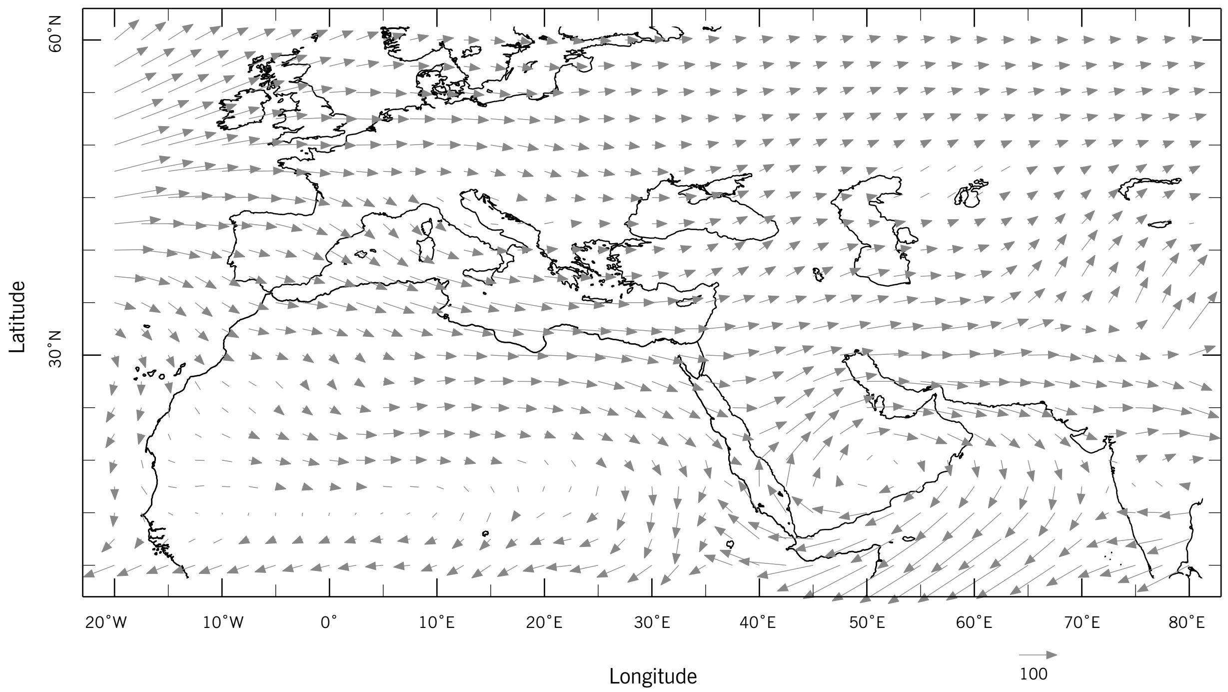


Fig. 1 Moisture vectors map; December – January – February; Europe, Mediterranean, North Africa, West Asia, Indus. The climatological vertically integrated moisture transport from the beginning of December to the end of February, as estimated for December 1949 to February 2014. The units are in kg/m/s, with the reference vector shown at the bottom.

Abb. 1 *Karte der Feuchtigkeitsvektoren; Dezember – Januar – Februar; Europa, Mittelmeerraum, Nordafrika, Westasien, Indusgebiet. Vertikal integrierter klimatologischer Feuchtigkeitstransport von Dezember bis Februar beruhend auf Schätzwerten von Dezember 1949 bis Februar 2014. Angaben in kg/m/s, der Vergleichsvektor ist unten angegeben.*

The 4.2–3.9 ka BP abrupt climate change event

The annual precipitation for the Mediterranean and West Asia is guided by the North Atlantic Oscillation (NAO; Kushnir/Stein 2010; Cullen et al. 2002) and delivered by the Mediterranean westerlies that pass through the Mediterranean trough to West Asia (Lionello et al. 2006). The westerlies' paths onto and across the West Asian land mass have been known from antiquity and well-documented since the early twentieth century (Wirth 1971, 82). The westerlies' variability, a function of the NAO, has been analysed recently and in detail for the instrumental period (Fig. 1; Cullen et al. 2002; Lionello et al. 2006).

During the pre-instrumental period, the abrupt century-scale megadrought interruptions of the westerlies at 8.2 ka BP, 5.2 ka BP, 4.2 ka BP, and 3.2 ka BP, still only partially explained, suddenly reduced cultivable dry farming areas in the eastern Mediterranean and West Asia, reduced both Nile and Tigris-Euphrates river flow, and forced adaptive social responses among the regions' varied polities, economies, and agricultural regimes (Weiss et al. 1993; Staubwasser/Weiss 2006). During the 30–50 % precipitation reductions and colder temperatures of the 4.2–3.9 ka BP abrupt megadrought, these adaptations are visible in West Asia, both archaeologically and epigraphically, as desertion of dry farming regions, habitat-tracking to cultivable riparian, paludal and karstic refugia, and the nomadisation/Amoritisation of dry farming populations (Weiss 2012; Weiss 2014). The social processes within these varied adaptations, however, remain occluded by still-absent archaeological and epigraphic data, the research programme targets for another generation of archaeologists.

The temporal frame of the 4.2–3.9 ka BP event's North Atlantic chronology and magnitude is now available within: 1. Icelandic lake sediment records (Geirsdóttir et al. 2013; Blair et al. 2015); and 2. a Greenland lake sediment record linked to the NAO index derived from tree-ring and speleothem records (Olsen et al. 2012). These temporal boundaries are reflected in the abundant and synchronous Mediterranean westerlies palaeoclimate proxy records, usually ^{14}C and uranium-thorium dated, that extend across seven sub-regions:

1. Coastal Spain and France

Doñana National Park: Jiménez-Moreno et al. 2015; Sierra de Gádor: Carrión et al. 2003; Cova da Arcola: Railsback et al. 2011; Borreguiles de la Virgen: Jiménez-Moreno/Anderson 2012; Lake Montcortès: Scussolini et al. 2011; Lac Petit: Brisset et al. 2013.

2. The central Mediterranean Italian lakes

Lago di Pergusa: Sadori et al. 2013; Peyron et al. 2013; Buca della Renella: Drysdale et al. 2006; Lago Alimini Piccolo: Di

Rita/Magri 2009; Maar lakes: Magri/Parra 2002; Magri/Sadori 1999; Lake Accesa: Magny et al. 2007; Peyron et al. 2013; Lago Preola: Magny et al. 2011; Corchia Cave: Regattieri et al. 2014.

3. Greece and Albania

Lake Lerna: Jahns 1993; Osmanaga Lagoon, Pylos: Zangger et al. 1997; Lake Vrana: Schmidt et al. 2000; Lake Prespa: Leng et al. 2010; Lake Shkodra: Zanchetta et al. 2012; Mazzini et al. 2015; Sadori et al. 2015; Lake Ohrid: Wagner et al. 2009; Lake Dojran: Francke et al. 2013; Aegean Sea: Ehrmann et al. 2007; Kuhnt et al. 2008; Triantaphyllou et al. 2014; Kotychi Lagoon: Haenssler et al. 2014.

4. Levant and Red Sea

Acre: Kaniewski et al. 2013a; Tweini: Kaniewski et al. 2008; Dead Sea: Migowski et al. 2006; Zeelim, Dead Sea: Langgut et al. 2014; Sedom, Dead Sea: Frumkin 2009; Soreq Cave: Bar-Matthews/Ayalon 2011; Shaban Deep: Arz et al. 2006; central Red Sea: Edelman-Furstenberg et al. 2009; Lake Hula: Baruch/Bottema 1999.

5. Anatolian plateau and northern Mesopotamia

Konya lakes: Roberts et al. 1999; Leng et al. 1999; Reed at al. 1999; Gölhisar Gölü: Eastwood et al. 1999; Eastwood et al. 2007; Leng et al. 2010; Eski Açıgöl: Roberts et al. 2001; Koçain Cave: Göktürk 2011; Abant Gölü: Bottema 1997; Yeniçaga Gölü: Bottema 1997; Söğütlü Marsh: Bottema 1997; Lake Iznik: Ülgen et al. 2012; Yenişehir: Bottema et al. 2001; Arslan Tepe: Masi et al. 2013; Göbekli Tepe: Pustovoytov et al. 2007; Lake Van: Lemcke/Sturm 1997; Wick et al. 2003; Lake Tecer: Kuzucuoğlu et al. 2011; Tell Leilan: Weiss et al. 1993.

6. Persian Gulf

Gulf of Oman: Cullen et al. 2000; Awafi: Parker et al. 2006; Parker/Goudie 2008; Qunf Cave: Fleitmann et al. 2003.

7. Black Sea, Caspian Sea, Iranian plateau

Lake Zeribar: Stevens et al. 2001; Lake Mirabad: Stevens et al. 2006, Schmidt et al. 2011; Lake Maharlu: Djamali et al. 2009; Black Sea: Cordova/Lehman 2005; Caspian Sea: Leroy et al. 2007; Leroy et al. 2014.

In addition to these Mediterranean westerlies proxies, synchronous abrupt alterations are evident in African and Indus proxies. These measure both Nile flow and Indus precipitation and river flow, functions of the Indian monsoon as it passes across the Arabian Sea between the sub-continent and the Horn of Africa (Fig. 1). The 4.2 ka BP event disrupted the Indian monsoon (Berkelhammer et al. 2012; Dixit et al. 2014; Prasad et al. 2014), West African (Marchant/Hooghiemstra 2004) and north-east African precipitation (Marshall et al. 2011; Revel et al. 2014; Thompson et al. 2000), and consequent Nile flow (Hassan et al. 2006; Bernhardt et al. 2012; Welc/Marks 2014). Saharan precipitation was similarly disrupted, as at Lakes Yoa (Kröpelin et al. 2008; Lézine 2009) and Jikariya (Wang et al. 2008), where the aridification and dust event terminated the »African Humid Period« and probably created the sources of synchronous African dust in Tuscany (Magri/Parra 2002).

Globally, the proxy evidence of the 4.2–3.9 ka BP event has accumulated rapidly (Walker et al. 2012). In China, numerous records now available suggest a relationship with the still-sketchy societal collapse events surrounding the Longshan Culture of the Yangtze valley[1]. In North America, the data extend across the continent[2] and include the Great Basin tree-ring record (Salzer et al. 2014), which revises the environmental reconstructions at the coincident introduction of maize agriculture into the south-west of the USA (Merrill et al. 2009) and the Yucatan (Torrescano-Valle and Islebe 2015). In South America, the well-known glacial record (Thompson 2000) is now supplemented with other proxies[3], suggesting a relationship with the poorly understood rise and fall of contemporary north Peruvian cities (Sandweiss et al. 2009).

The multi-proxy stack

A Mediterranean westerlies multi-proxy stack (Fig. 2) portrays the high- to low-chronological resolution presently available for the proxy excursions at 4.2–3.9 ka BP. Linear interpolation across uranium-thorium or ^{14}C dated points is provided for measured quantities of stable isotopes, arboreal and other pollen, diatoms, carbonates, lake levels, magnetic susceptibility, or other climate proxies. The stack (Weiss et al. 2012; Walker et al. 2012) illustrates the ranges of chronological resolution within two standard deviations around 4.2–3.9 ka cal BP. In addition, for comparative purposes, the coincident high-resolution chronologies at Mawmluh Cave (Berkelhammer et al. 2012) and Mount Logan (Fisher 2011) are shown, illustrating the global extent of the 4.2 ka BP event.

At Lago Alimini Piccolo, Italy (Di Rita/Magri 2009), the radiocarbon dated lake core shows a decrease in arboreal pollen, suggesting deforestation (Magny et al. 2009; Zanchetta et al. 2012). The Koçain Cave, Turkey speleothem (Göktürk 2011), provides high-resolution uranium-thorium dates that constrain abrupt decreases and increases of $\delta^{18}O$. The Eski Açıgöl, Turkey, lake core (Roberts et al. 2001) has no radiocarbon dates during a decline in lake core charcoal, misinterpreted as anthropogenic deforestation (Turner et al. 2008), while the Gölhisar, Turkey, lake core (Eastwood et al. 2007) carbonate spike and rise in $\delta^{18}O$ are framed by radiocarbon dates 2000 years apart. The Lake Van, Turkey, core (Lemcke/Sturm 1997) displays a quartz spike understood as

1 Dykoski et al. 2005; Wang et al. 2008a; Schettler et al. 2006; Cai et al. 2010; Liu et al. 2010; Lu et al. 2015.

2 Dean 1997; Booth et al. 2005; Zhang/Hebda 2005; Li et al. 2007; Menounos et al. 2008; Hardt et al. 2010; Fisher 2011.

3 Baker et al. 2009; Licciardi et al. 2009; Licciardi et al. 2006; Schittek et al. 2015.

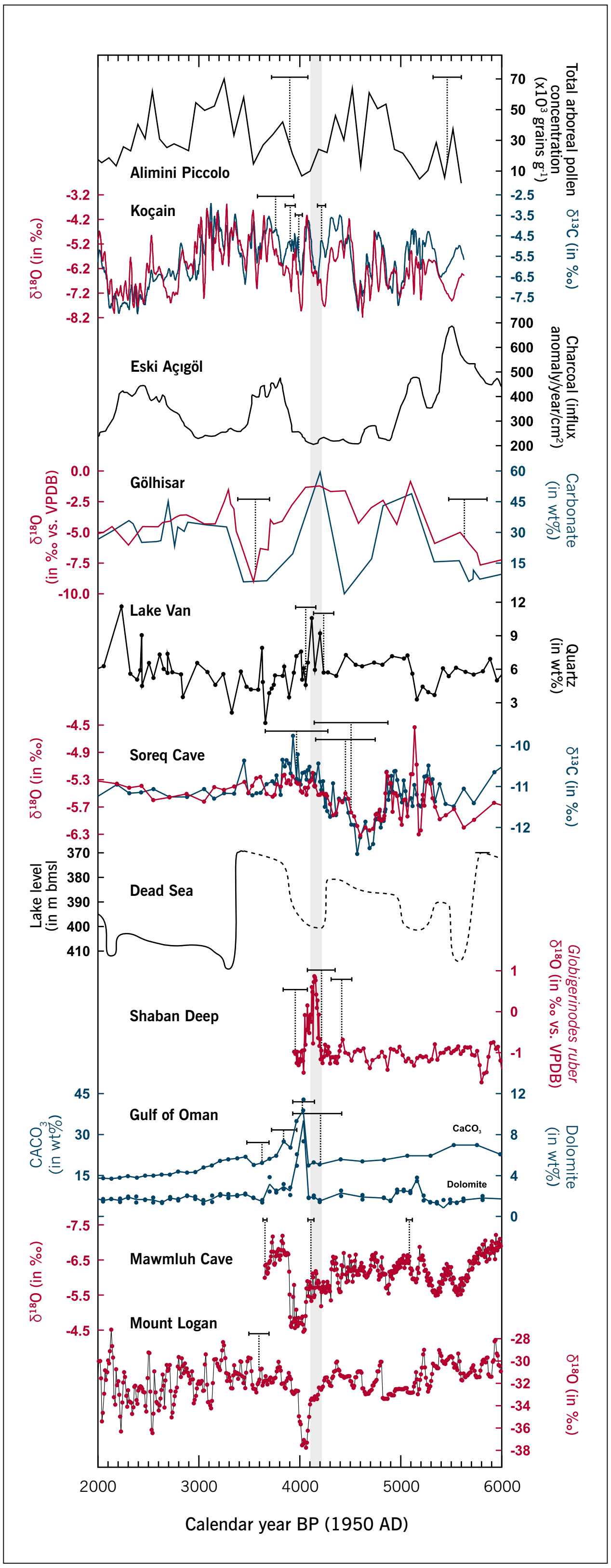


Fig. 2 Multi-proxy stack of Mediterranean westerlies and related palaeoclimate proxies displaying the 4.2 ka BP abrupt climate change event within marine, lake, speleothem, and glacial records of varying chronological resolution and two standard deviations.

Abb. 2 *Aufstellung mehrerer Proxydaten von mediterranen Westwinden und verwandter paläoklimatischer Proxies, die den abrupten Klimawechsel um 4,2 ka BP mittels Meeres-, Seen-, Speläothem- und Gletscherdaten in unterschiedlicher zeitlicher Auflösung mit zweifacher Standardabweichung anzeigen.*

a dust proxy dated by varve counts with slight errors (see Kuzucuoğlu et al. 2011). The dense sampling intervals for the Soreq Cave, Israel, speleothem (Bar-Matthews/Ayalon 2011) δ¹⁸O and δ¹³C values are linked to uranium-thorium dates, but with large standard deviations that provide a labile chronology. The Dead Sea lake levels (Migowski et al. 2006) are estimated to have dropped 45 m (see Frumkin 2009) during this period. In the Red Sea Shaban Deep core (Arz et al. 2006), 15-year diatom sampling intervals are constrained by high-resolution radiocarbon dates with a marine reservoir correction (see Edelman-Furstenberg et al. 2009).

The Gulf of Oman marine core (Cullen et al. 2000) has dolomite and calcium carbonate (dust) spikes framed by ¹⁴C dates and is tephra-linked to the Tell Leilan chronostratigraphy (Weiss et al. 1993). The Mawmluh Cave, India, speleothem (Berkelhammer et al. 2012) provides 6-year δ¹⁸O sampling intervals constrained with uranium-thorium dates and links the Nile flow reductions (see Hassan et al. 2006; Bernhardt et al. 2012), East African lake level reductions (see Gasse 2000), and the Indian summer monsoon deflection (see Dixit et al. 2014). The Mount Logan, Yukon, glacial core (Fisher 2011) is cross-dated with the NorthGRIP-core and dated tephra records, and exemplifies the event's North American expression, second in magnitude to the 8.2 ka BP event.

Illustrative of the distribution of synchronous high-resolution proxies are the Lac Petit, France, core (Brisset et al. 2013) tied to other recent and adjacent cores at Lake Shkodra[4], Lake Accesa (Magny et al. 2009; Zanchetta et al. 2012), and Acre (Kaniewski et al. 2013a), dated c. 4.2–3.9 ka BP, or in some cases c. 4.3–3.8 ka BP.

Statistical tests of synchronicity remain a desideratum for further dating refinement of the 4.2 ka BP megadrought. The complexity of the event, now evident in some high-resolution proxy records, and the precise, sub-decadal, start and end dates remain a challenge to the societal response record that is often measured within a multi-decadal frame, as in the case of the Mesopotamian regnal years (Sallaberger/Schrakamp 2015) and the Tell Leilan radiocarbon chronology (Weiss et al. 2012).

Societal adaptations

The global distribution of the records for this event is the product of more than twenty years' Holocene palaeoclimatology research. The archaeological and epigraphic record of societal responses to the 4.2–3.9 ka BP event has grown gradually over 75 years, to the point where the societal responses are almost a sub-field of Old World archaeology, including

4 Zanchetta et al. 2012; Sadori et al. 2013; Sadori et al. 2015; Mazzini et al. 2015.

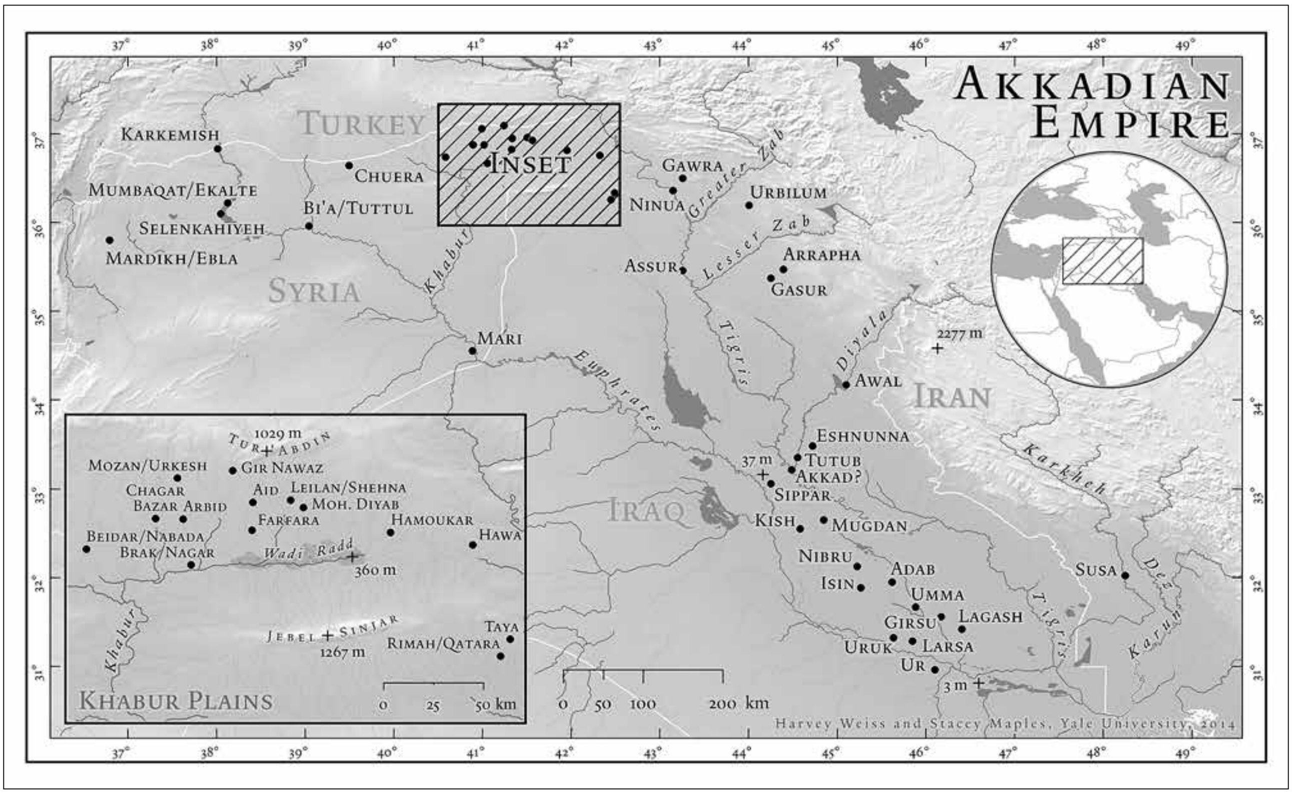


Fig. 3 The Akkadian Empire, c. 2250 BC, with Khabur Plains settlement and topographic elevations.

***Abb. 3** Das Akkadische Reich um 2250 v. Chr. mit der Besiedlung der Chaburebene und topografischen Höhenlagen.*

its Mediterranean, West Asian, Central Asian, and East Asian realms. The societal responses mirror the event's chronology, and punctuate the usually gradual archaeological record with their abruptness, magnitude, duration, and extent: societal collapses, regional abandonments, habitat-tracking, and trans-regional nomadisation. A new chronological clarity, that substantiates trans-regional synchronicity and dispels some time-transgressive notions (e. g. Roberts et al. 2011), is available through the use of high-resolution AMS-radiocarbon dates and Bayesian wiggle-matching of radiocarbon date sequences (Ramsey et al. 2010; Weiss et al. 2012).

The West Asian record also extends across the boundaries of literacy, as it contributes the literate and boastful first empire, Mesopotamia's Akkadian Empire, with its bold, innovative settlements, monuments and art, eloquent poetic laments, king lists and royal inscriptions, and trans-regional conquests and imperialisation, each unique for its time. Also stunning, however, is the archaeological observation that the collapse of the Akkadian Empire was sudden, abrupt, unforeseen, and now best recorded archaeologically on the Khabur Plains of north-eastern Syria. This has prompted some debate, as Akkadian imperial expansion and collapse now challenge long-standing orthodoxies about principally endogenous societal collapse.

Imperialisation and collapse

In the early 24th century BC, in southernmost Mesopotamia, the period of the warring states of Sumer terminated with one »lord of the land«[5]. Lugalzaggisi, the king of the city-state of Umma, emerged from decades-long battles with control of many, if not all, neighbouring city states, such as Nibru, Adab, and Uruk, the first of these being dozens of kilometres distant from Umma (Almamori 2014). The surrounding events are known only sketchily, but include Lugalzaggisi's conquest of Mari on the central Euphrates, and royal travel as far as the Mediterranean (Fig. 3).

This supremacy over Sumer took a quantitative and qualitative leap in the immediately succeeding decades – for reasons yet unknown. The next ruler, according to the Sumerian King List, was Sargon, the founder of a six-generation-long dynasty that created a capital city at Akkade (probably near Sippar but still not located), and within two generations embarked upon an imperial venture that was exponentially more extensive and extractive than that of Lugalzaggisi, »lord of the land«. This first imperial effort, the Akkadian Empire, was truncated by natural forces, the 4.2 ka BP event, only about one hundred years after its launch and full-blown development, but its successes were emulated and venerated for the next thousand years. Deploy-

5 The historical chronology for Mesopotamia and Syria here follows the »Middle Chronology«, and its minor variants with a range of thirty years (Sallaberger/Schrakamp 2015), which are in accord with the Leilan radiocarbon chronology (below) for late 3rd millennium BC northern Mesopotamia.

c. BC	Ruler	Territorial control	Area (estimated km^2)
2350	Lugalzaggisi	Ur to Kish	3000
2300	Sargon	Akkad to Ur	5000
2250	Naram-Sin	Akkad to Ur, Susa, Mari, Ešnunna, Awal, Gasur, Ninua, Taya, Leilan, Mozan, Brak	30 000
2200	Post-collapse	Akkad	1

Tab. 1 Expansion and collapse of the Akkadian Empire.

Tab. 1 *Ausbreitung und Zusammenbruch des Akkadischen Reichs.*

ing both epigraphic and archaeological data, the establishment of Akkadian imperial power can be outlined in three stages.

Stage 1

Sargon (c. 2324–2285 BC): Sargon extended the united realm from Akkad in the north to Ur in the south, approximately 5 000 km^2, and embarked upon a series of long-distance conquests up the Euphrates, to Mari, Tuttul, and Ebla. This was a departure from regional southern Mesopotamian city conquest, and a qualitative leap from both Mari's and Ebla's more restricted efforts towards regional hegemony. These conquests did not, however, leave controlling fortresses at the conquered cities; they provided only the »primitive«, immediate, acquisition of plunder.

Stage 2

Rimush and Manishtushu (c. 2284–2262 BC): Brak, Nineveh, and Leilan in northern Mesopotamia. The extension of irrigation-agriculture based Akkadian imperial power into dry farming northern Mesopotamia followed shortly thereafter, and for reasons similarly unknown. The imperial Akkadian presence is evident at three loci:

1. Tell Brak, on the marginal edge of the fertile Khabur Plains, where a Rimush-inscribed vase fragment was retrieved (Sallaberger/Schrakamp 2015, 105);
2. Nineveh, on the river Tigris as it crosses the fertile Assyrian plains, where Shamshi-Adad recorded his reconstruction of a temple repaired earlier by Manishtushu (Grayson 1987, 53);
3. Tell Leilan, in the centre of the Khabur Plains, where the earliest Khabur Plains Akkadian texts were retrieved from the period IIb3 Akkadian schoolroom (Lillis Forrest et al. 2007).

Stage 3

Naram-Sin (c. 2261–2206 BC): conquests to west, conquest of Khabur Plains and »Great Rebellion«. During the reign of Naram-Sin, Sargon's grandson, another qualitative leap was taken. The Akkadian forces now conquered adjacent dry farming regions in south-western Iran, north-eastern Iraq, and north-eastern Syria, and installed themselves within palace fortresses as at Leilan, Mozan, and Brak, on the Khabur Plains, and henceforth extracted and deployed revenues from both the rain-fed and the irrigation-agriculture regions of Mesopotamia. This imperialisation across Mesopotamia is documented in the collection of taxes and finished products (Glassner 1986), imperial archives (e. g. Visicato 1999), the implementation of new imperial standard measures for collection of imperial revenues (Powell 1990), and the creation of imperial agricultural domains using land surveying and agrimensorial innovations (Foster 2011; Høyrup 2014). In southern Mesopotamia, the »Great Rebellion« was defeated, and Naram-Sin was deified in celebration (Tab. 1).

Across the Khabur Plains, at the major city sites of Mozan, Leilan, and Brak, the depth and extent of the Naram-Sin period Akkadian imperial control is manifest in the monumental public buildings, Akkadian administrative texts, sealings of imperial revenues, and standardised flat-based »$sila_3$-bowls« probably for worker ration distribution that occur frequently within excavated samples at each of these cities (Senior/Weiss 1992). Impressive epigraphic representations become common and include the name-stamped lower-course bricks at Brak's unfinished Naram-Sin fortress (Mallowan 1947, 66 pl. 64), the sealings of the daughter of Naram-Sin, wife of the ruler, at the Mozan Akkadian palace (Buccellati and Kelly-Buccellati 2002), and the seal impression of Haya-abum, the Akkadian *šabra*, at »The Unfinished Building« (TUB), Tell Leilan (Weiss et al. 2012, 173).

To the limits of efficient transport, the extractive imperial success was apparently unfettered. The extortion of land and estates from local southern powers, the conquest and rebuilding of distant cities like Leilan/Shekhna, Brak/Nagar, Nurrugum, and Ninua, the crushing defeat of the »Great Rebellion«, and the deification of Naram-Sin all suggest effective intimidation, terror, and large military forces. But however certain the conveyance of the Akkadian extractions, the means remain unclear. For example, how were imperial revenues collected and then delivered from Gasur/Yorgan Tepe to Akkad? Were the revenues collected at Aššur, disposed at Aššur, or removed to Akkad? The very large grain shipments from $NAGAR^{ki}$, probably Tell Brak (Na-gàr^{ki}, Ebla; Na-ga-ar^{ki}, elsewhere; Gelb 1961, 191) were removed from the Khabur Plains and collected at imperial Sippar (CT 1: 1b, 2,7; 1c, 12). By which water-borne route were these twenty-nine tons of cereal harvest, probably collected in the fields of Mozan and Leilan-Mohammed Diyab, dispatched to Sippar – and who controlled their measurement (Sommerfeld et al. 2004)? The divide between state and private interests in such imperial extractions was probably porous, as in the famous activities of the *šabra*-s (Brumfield 2013), and as in empires today.

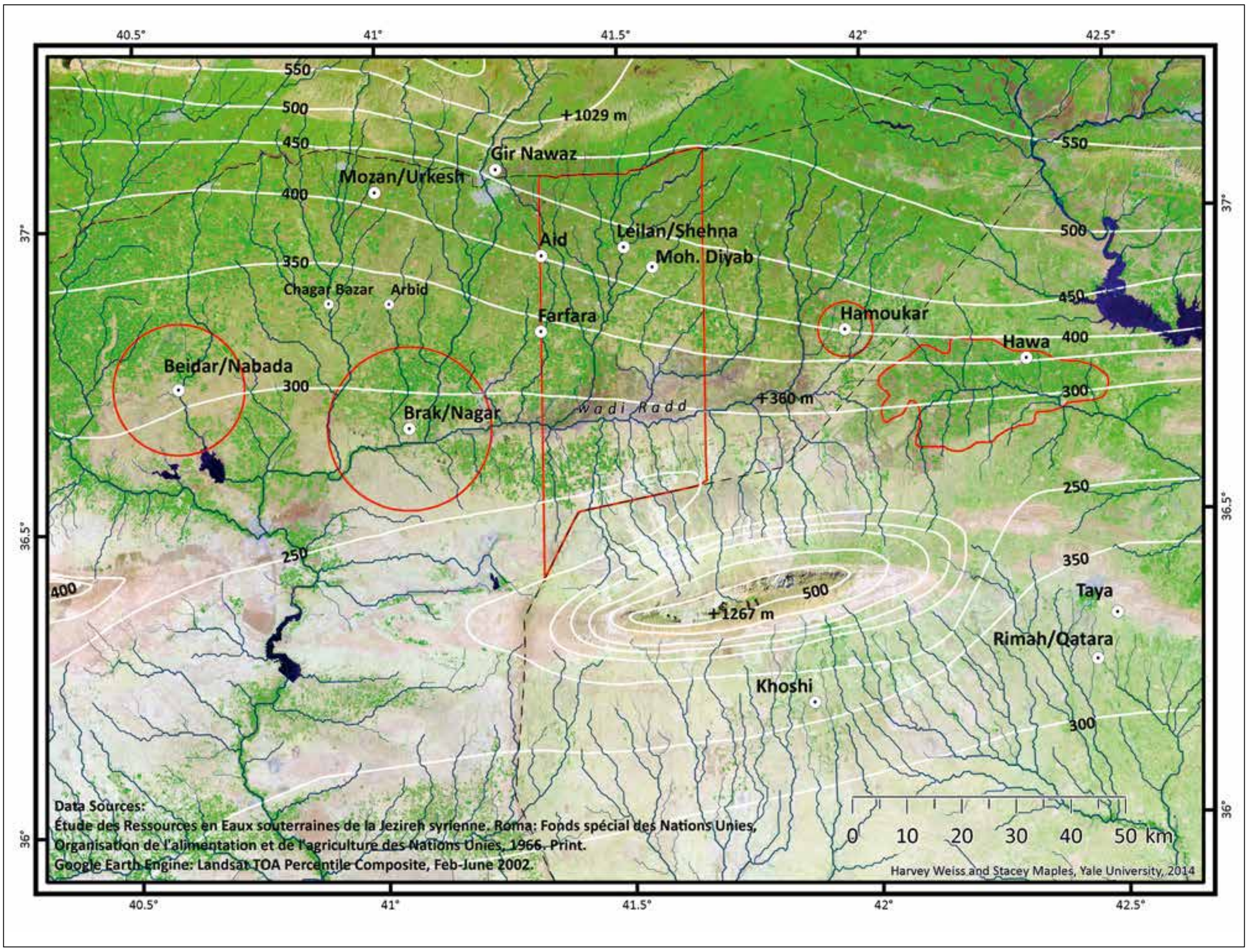
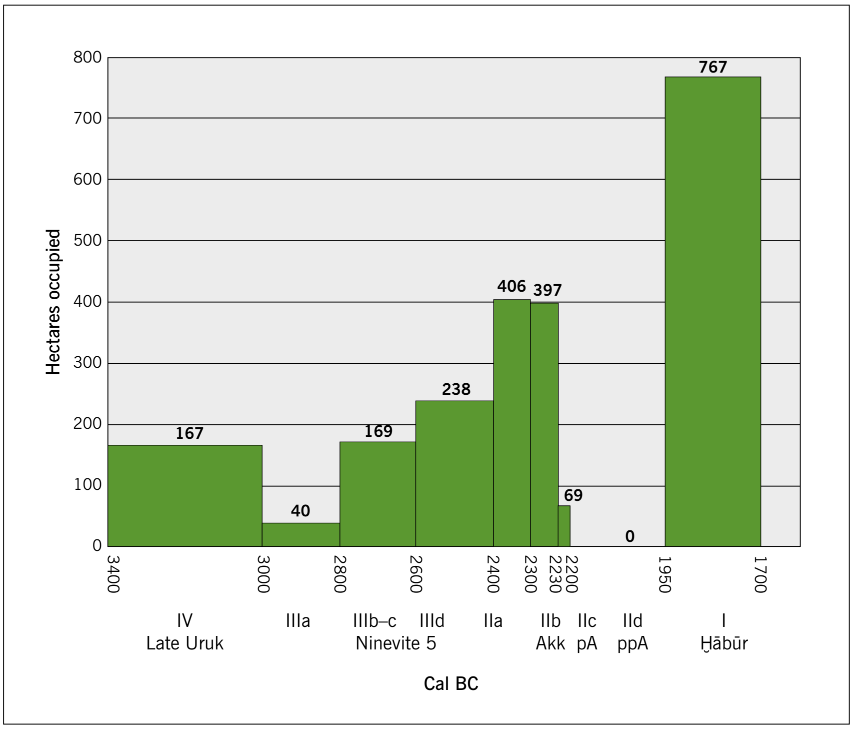


Fig. 4 The Khabur Plains in north-eastern Syria with modern precipitation isohyets and regional archaeological settlement surveys (red bordered areas).

Abb. 4 *Die Chaburebene im Nordwesten Syriens mit modernen Niederschlagshöhenlinien und regionalen archäologischen Siedlungssurveys (rot umrandete Flächen).*

Fig. 5 Leilan region survey (1650 km²) histogram of settlements (in ha) per period spans. The Akkadian collapse at the end of period IIb reduced settled areas by around 87 % at c. 2230 BC. Major resettlement by formerly pastoralist Amorite populations (Khabur-ware occupations) is evident by c. 1950 BC. Akk – Akkadian; pA – post-Akkadian; ppA – post-post-Akkadian.

Abb. 5 *Balkendiagramm der im Leilan-Survey erfassten Siedlungsausdehnungen (in ha) je Zeitperiode. Der akkadische Zusammenbruch am Ende von Periode IIb um 2230 v. Chr. hatte eine Siedlungsreduktion um ca. 87 % zur Folge. Eine großräumige Wiederbesiedlung durch amoritische ehemalige Nomadenpopulationen (Siedlungen mit Chabur-Ware) lässt sich um 1950 v. Chr. erkennen. Akk – akkadisch; pA – post-akkadisch; ppA – post-post-akkadisch.*



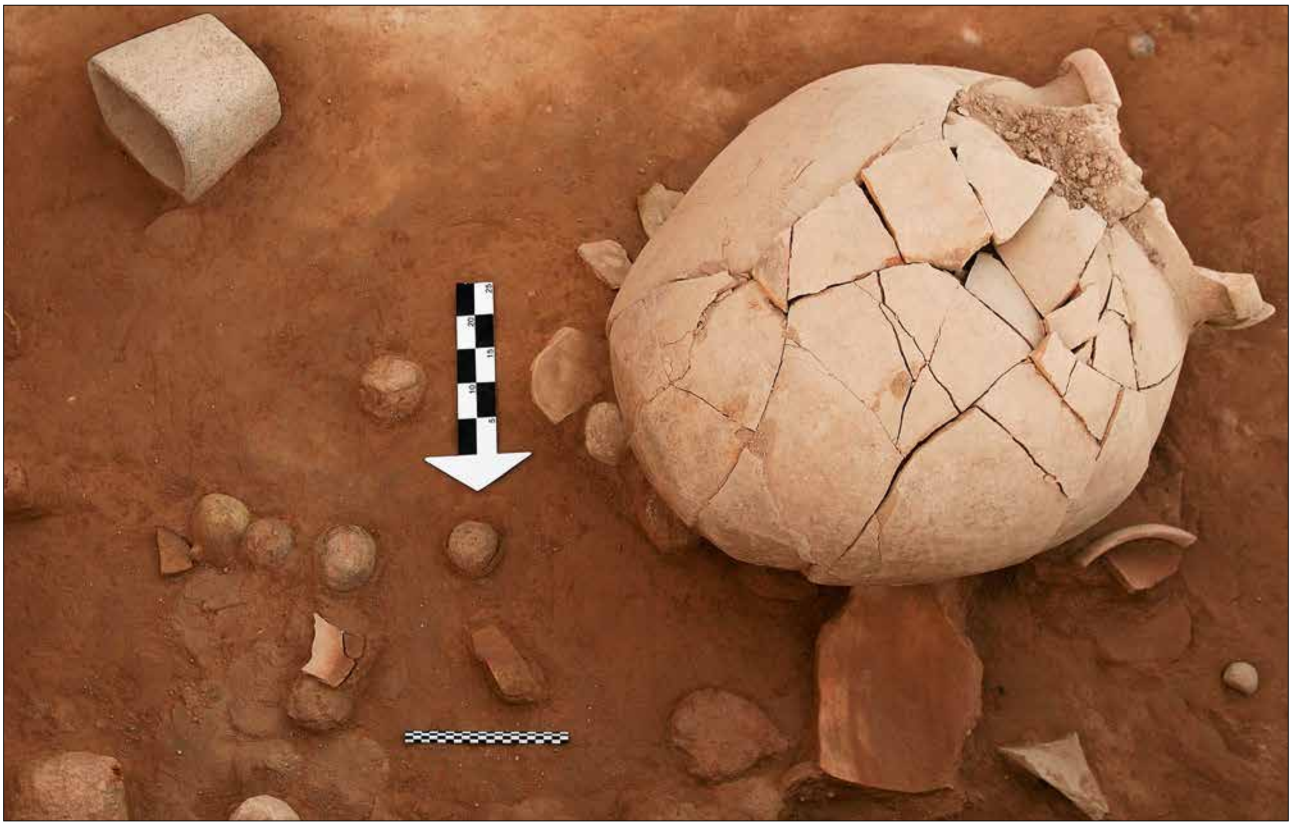


Fig. 6 Tell Leilan. Akkadian collapse and abandonment: room 12 floor, terminal occupation, »Akkadian Administrative Building«, end of period IIb1, 2254–2220 cal BC (68.2 %). Clay balls for tablet manufacture, uninscribed clay tablets, a 2 l basalt measure, and a cereal storage vessel were abandoned on terminal floor.

Abb. 6 *Tell Leilan. Zusammenbruch des Akkadischen Reichs und das Verlassen von Siedlungsräumen: Boden in Raum 12, letzte Phase der Besiedlung, »akkadisches Verwaltungsgebäude«, Ende der Periode IIb1, 2254–2220 cal BC (68.2 %). Tonkugeln zur Tafelherstellung, unbeschriftete Tontafeln, ein 2 l Maß aus Basalt und ein Vorratsgefäß für Getreide wurden auf dem Fußboden zurückgelassen.*

Collapse at 4.2 ka BP

When precipitation dropped abruptly by approximately 30–50 % at 4.2 ka BP (Bar-Matthews/Ayalon 2011; Frumkin 2009), the dry farming cultivable land areas narrowed (Staubwasser/Weiss 2006, 380 f. Fig. 4; 5) and regional aggregate cereal yields plummeted. Marginal production areas, such as the area around Tell Brak (289 mm/annum today) dropped below the requirements of cereal agriculture, as did the environs of higher rainfall Tell Leilan (450 mm/annum today).

The Akkadian Empire's collapse and abandonment of the Khabur Plains was swift and sudden, and with it departed most of the indigenous regional population. The Tell Leilan region survey, a thirty-kilometre wide, north-south, 1650 km² transect through the heart of the eastern Khabur Plains, documents an 87 % reduction in settled area for the post-Akkadian Leilan IIc period and complete abandonment 30–50 years later (Arrivabeni 2012; Ristvet 2012). The elimination of imperial revenues from the Khabur Plains and the other imperialised dry farming plains truncated their flow to the Akkadian capital; but this flow and its southern Akkadian deployment remain to be quantified (Fig. 4–5).

Evocative epigrams for the Akkadian collapse in southern Mesopotamia included »On its canal-bank towpaths the grass grew long« (Curse of Akkade: Black et al. 2004, 124) and »Who was king, who was not king« (Sumerian King List: Glassner 1993, 140), while in northern Mesopotamia the period following the collapse was recorded as »(…) seven generations since the Fall of Akkad« (Shamshi-Adad: Grayson 1987, 53; Glassner 2004, 22), with the predecessors of Shamshi-Adad's lineage famously designated as »the seventeen [Amorite] kings who lived in tents« (Assyrian King List: Glassner 2004, 147).

The minimal contemporary epigraphic record for the Akkadian collapse (Glassner 1986) is now, however, amplified and quantified through recent archaeological measurement of regional site abandonments, site-size reductions, and high-resolution, radiocarbon dated rates of change on the Khabur Plains.

Akkadian collapse and abandonment on the Khabur Plains

Tell Brak

The Akkadians built several public structures at the north and south edges of the approximately 40 ha large Tell Brak/Nagar acropolis and created a worker settlement of about 30 ha size at its southern base. Less than fifty years later the acropolis and the lower town were abandoned suddenly, while the Naram-Sin palace (Mallowan 1947), a grain storeroom, was abandoned while probably still under construction (Weiss 2012).

Following the Akkadian abandonment, short-lived houses were constructed at sparsely distributed loci across the Brak acropolis (Colantoni 2012). These included the post-Akkadian ramshackle pisé construction on top of the abandoned formal Akkadian building in area TC. These were all abandoned at c. 2200 BC (Emberling et al. 2012) along with three excavation-sampled villages north of Tell Brak. Hence the Akkadian collapse at Brak consisted of the immediate 50 % abandonment of the site area, including all monumental buildings and the lower town, followed by abandonment of less-dense, dispersed pisé residences by 30–50 years later. Thereafter, at c. 1950 or 1900 BC some Khabur-ware related houses appeared at Tell Brak's western (HH) and north-western (HN) acropolis edges (McDonald/Jackson 2003).

Tell Leilan

The Akkadian scribal room, dated stratigraphically, palaeographically, and by radiocarbon, was established late in Leilan period IIa, which can now be called Leilan IIb3, on the north-west Leilan acropolis (Lillis Forrest et al. 2007). Shortly thereafter, the period IIa palace, across the stone-cobbled street, was destroyed by the Akkadians, and then replaced with a palace with more than 17 rooms, the »Akkadian Administrative Building«, in Leilan IIb2-1, reusing the remnant IIa palace glacis and some of its brickwork. For several decades in the late 23rd century BC, large-scale grain storage, processing, and distribution were Akkadian-directed imperial activities here. When the Akkadians suddenly abandoned 90 ha Tell Leilan, with the acropolis and the lower town, they left clay balls for tablet manufacture, uninscribed clay tablets, a large storage vessel, and a 2 l ground stone measure on the terminal room 12 floor in the »Akkadian Administrative Building«. That abandonment of the »Akkadian Administrative Building« and the end of Leilan IIb1 are now radiocarbon dated to 2254–2220 cal BC (68.2 %; Fig. 6; Weiss et al. 2012).

TUB, across the stone-cobbled street from the »Akkadian Administrative Building«, was similarly abandoned. Here were rough-dressed basalt block walls still without bricks, and some partially-built mudbrick walls of only three or four courses upon a mud-set sherd layer atop the basalt blocks. This construction effort had not yet reached the stage of floor preparation, but sub-floor plumbing had already been installed (Lillis Forrest et al. 2007). A semicircle of partially dressed blocks awaited finishing and wall placement, and a line of basalt blocks extended west to the edge of the acropolis, where they were still a visible outcrop in 1978. At desertion, the string-impressed clay sealing of the imperial Akkadian minister, *»Haya-abum, šabra«* (Leilan object number L93-66), was left on TUB's construction surface (Fig. 7–8; Weiss et al. 2012; McCarthy 2012).

In the immediately subsequent post-Akkadian Leilan IIc period, a four-room house was built on top of the abandoned Akkadian palace. The abandonment of the Leilan IIc house is now ^{14}C dated to 2233–2196 cal BC (68.2 %), only 30–40 years after its construction. Thereafter, only Early-Khabur-ware strata, radiocarbon dated to some 250 years later, appear at Tell Leilan (Fig. 9; Weiss et al. 2012).

Mohammed Diyab

Only 8 km east of Tell Leilan, Tell Mohammed Diyab's two Akkadian buildings (levels 6a-4 and 5a-12), like TUB at Tell Leilan, were incomplete at abandonment. Together, therefore, Mohammed Diyab and Leilan seem to have comprised an Akkadian conurbation of 140 ha in the centre of the Khabur Plains. The relative chronology of the Akkadian desertion of Mohammed Diyab is also intriguing: here TUBs' wall constructions were stopped prior to any brick laying (Nicolle 2006, 64; 133).

Tell Mozan

Tell Mozan/Urkesh was a city of approximately 100 ha, located 8 km from the Tur Abdin mountains astride a remnant wadi. The area AA, level 2 Akkadian-period palace, built of dressed basalt blocks and mudbrick, was abandoned along with the city's 100 ha lower town area at the time of the Akkadian abandonments at Brak and Leilan. After its aban-

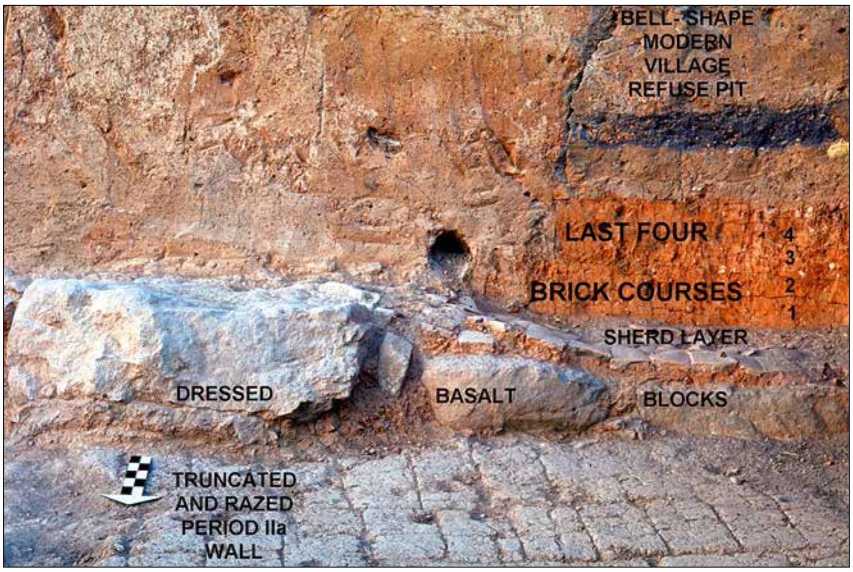


Fig. 7 Tell Leilan. TUB, end of period IIb1, 2254–2220 cal BC (68.2 %), south stratigraphic section showing the point at which brick-laying upon dressed basalt foundation stones ceased.

Abb. 7 *Tell Leilan. Das »Unfertige Gebäude« (TUB), am Ende von Periode IIb1, 2254–2220 cal BC (68.2 %), Südprofil. Der Moment, als die Aufmauerung auf den bearbeiteten Basaltfundamenten abbrach, ist gut sichtbar.*

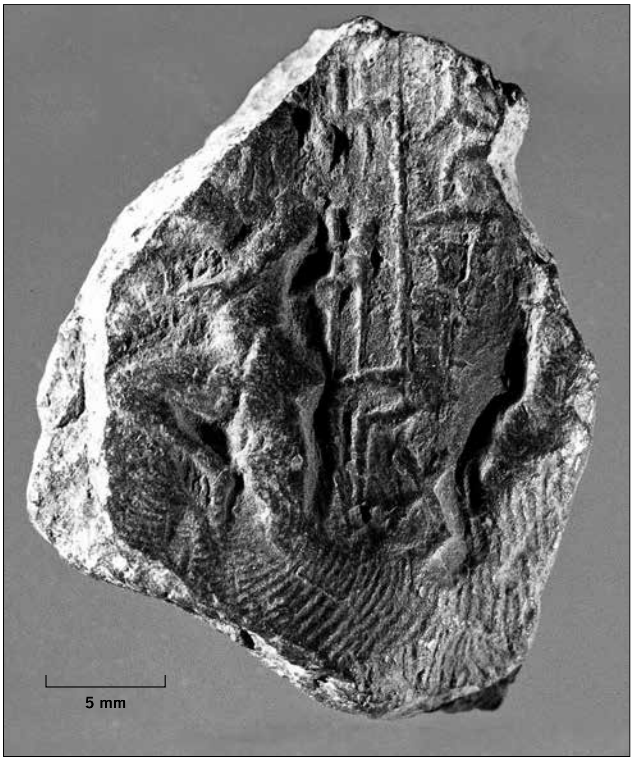


Fig. 8 Tell Leilan. Clay seal impression of *»Haya-abum, šabra,«* retrieved on the unfinished working floor at TUB, period IIb1. Reverse: string impressed.

Abb. 8 *Tell Leilan. Tonsiegelabdruck* »Haya-abum, šabra« *vom unfertigen Arbeitsniveau im TUB, Periode IIb1. Rückseite: Fadenabdrücke.*

donment, a few buildings were constructed on parts of the remnant 20 ha of the acropolis (Pfälzner 2012): a scatter of briefly occupied post-Akkadian houses (Buccellati/Kelly-Buccellati 2000, Fig. 5; 6) and a house with a fragment of an Ur III-period tablet and a late Akkadian or Ur III seal impression (Pfälzner 2012). This remnant-wadi refugium at the mountains' base was occupied for another hundred years, became a caravan stop after Leilan/Shubat Enlil in the 18th century BC, but was then abandoned.

Hamoukar

At the eastern edge of the Khabur Plains, the 100 ha occupation at Hamoukar probably terminated at the end of the Akkadian period. There are no utilisable radiocarbon dates from Hamoukar, but »early post-Akkadian« pits seal the last Hamoukar occupation (Gibson 2001), and thereby set its abandonment date at c. 2200 BC.

The Euphrates River

Away and apart from the Akkadian imperialised realms, state polities and region-wide settlements were similarly affected by precipitation, reduction, and agricultural disturbance. The river Euphrates' flow was diminished, but did not cease, during this period. Hence, habitat-tracking (Coope 1979; Eldredge 1985) from desiccated dry farming areas to irrigation agriculture Euphrates River refugia was one response of dry farming sedentary agriculturalists and Hanaean pastoralists that created the hypertrophic cities of Ur III in southern Mesopotamia.

Urban settlement flourished and expanded during this *shakkanaku*-period at Mari (Butterlin 2007), at Terqa with its public buildings, as well as Tuttul, Emar, Carchemish, and Samsat (perhaps Urshu), each 40 ha or larger. But Tell Sweyhat on the Euphrates terrace, removed from the floodplain's irrigation-sustained fields, was abandoned. Dry farming cities within the upper Euphrates drainage near Urfa and Harran, at Tilbeşar, Titriş, and Kazane were, of course, abandoned.

Dry farming in Western Syria and the steppe

The wealth and power of Ebla on the Idlib Plains made it the famous target of the Akkadian or Mari coalition forces that destroyed its palace c. 2300 BC. Following a short occupational hiatus, the succeeding Early Bronze IVB city of this time period was reduced in size and ruled from the Archaic palace, with its unique water cisterns. The palace construction, however, remained unfinished, like the buildings at Leilan and Brak, and the city was destroyed again c. 2000 BC (Matthiae 2013). At this same time, habitat-tracking to the Madekh swamp resulted in settlement expansion at Tell Touqan (Baffi/Peyronel 2013). Nearby, the Jabbul Plain, with the 20 ha large town at Umm el-Marra, at the limits of dry farming cultivation prior to 2200 BC, was abandoned during the aridification period (Schwartz et al. 2012). Rawda and its environs further south in the semi-arid marginal zone were also abandoned at c. 2200 BC (Barge et al. 2014). There the radial planned town, an unexplained phenomenon from the Khabur Plains to the Orontes River, was the settlement outpost facing, or replaced by, the nomad-repelling Très Longue Mur during the aridification (Geyer et al. 2010). The extended pastoralist cemeteries of this period at the Jebel Bishri possibly mirrored tribal units in the spatial distribution of stone-lined and cairn-marked inhumations (Ohnuma 2010).

Orontes River

The Orontes River provides a unique environmental contrast with the Jabbul and Idlib Plains. Here the karstic Aïn ez-Zarka drains a slow infiltration system with 10 billion m^3 of phreatic zone storage and a mean residence currently around 40 years (Wirth 1971). Hence, during this 300-year period of reduced precipitation, the Orontes River and its Amuq Plain debouchment attracted and sustained large sedentary agricultural populations (al-Maqdissi 2010; Yener 2005). The karstic springs of the Orontes system include those that provided the stream flow at the 100 ha large Mishrifé/Qatna, blocked to create a greater than 70 ha large artificial lake and irrigation agriculture during the city's late 3rd millennium BC growth (Morandi Bonacossi 2009, Fig. 5). Survey and excavation along the Orontes River have also documented the synchronous and sudden growth of the square-walled, Qatna-like, 76 ha large Nasriyah, the smaller, but similarly square-walled, Tell She'irat (al-Maqdissi 2010), and the first occupations at the 70 ha large Acharné, ancient Tunip, where 175 karst springs debouche into the paludal Ghab depression (Voûte 1961).

On the western side of the karst plateau, along the fertile littoral, springs provided for the town at Tell Arqa and its villages and for Tell Sukas. Coastal Syria and Lebanon otherwise seem to lack karst springs, apart from the Jeita Cave, along the Nahr el-Kalb valley near Beirut. Hence, population reductions and site abandonments were experienced at Ugarit and Byblos at this time.

Synchronous and similar-scale abandonments occurred across the dry farming realms of Palestine (Haiman 1996; D'Andrea 2012; Harrison 2012), Anatolia (Boyer et al. 2006), the eastern Mediterranean (Weiberg/Finne 2013; Davis 2012; Weiss 2000, 89 f.), and Turkmenistan (P'yankova 1994), while habitat-tracking to riparian refugia occurred along the Euphrates River in both southern Mesopotamia and Central Syria, along the Orontes River, and at the karst springs of Palestine (Weiss 2012).

Nomadisation

The archaeological data for massive regional abandonment and collapse as well as the settlement displacement data for the movement of (estimated) 300 000 persons over 300 years are supplemented, in the Mesopotamian case, with epigraphic documentation for Hanaean/Amorite pastoral nomad activity during the period following the Akkadian collapse (c. 2100–2000 BC; the southern Mesopotamian Ur III period), followed by the Isin-Larsa and early Old Babylonian period (c. 2000–1800 BC) for the emergence of these new Amorite dynasts in both southern and northern Mesopotamia. The first period sees the construction of walls against the nomads, such as »The Repeller-of-the-Amorites«, in the Ur III period, attesting to the futile efforts to control pastoralist movement from northern Mesopotamia into the south (Gasche 1990). The second period witnessed two processes: in southern Mesopotamia, the emergence of these Hanaean/Amorite pastoralists as the controlling dynasts of southern Mesopotamian cities (Finkelstein 1966); and in northern Mesopotamia, the sedentarisation of former Hanaean pastoralists within the resettlement that accompanied the return of pre-4.2 ka BP precipitation (Heimpel 2003; Ristvet 2008). This latter process, of course, enfolds the rise to paramountcy of Shamshi-Adad and the creation of new regional capital cities at Ekallatum and Shubat Enlil, beginning as early as in the late 20th century BC (Weiss et al. 2012).

These pastoralist processes presuppose an earlier third process that remains poorly documented archaeologically and epigraphically: the nomadisation of Mesopotamia at the 4.2 ka BP megadrought collapse (Ristvet/Weiss 2013). While some populations from northern Mesopotamia, such as those of the Khabur Plains, Western Syria, and the Assyrian

Fig. 9 Tell Leilan. The post-Akkadian four-room house built around a courtyard, period IIc, 2233–2196 cal BC (68.2 %). It was occupied briefly after the Leilan period IIb1 Akkadian site abandonment. This is the only post-Akkadian occupation yet located at Tell Leilan.

Abb. 9 *Tell Leilan. Nach-akkadisches Gebäude mit vier um einen Hof angelegten Räumen, Periode IIc, 2233–2196 cal BC (68.2 %). Es war nach Aufgabe der akkadischen Siedlung der Periode IIb1 für eine kurze Zeit bewohnt. Bis heute ist dies der einzige Nachweis für eine nach-akkadische Besiedlung Tell Leilans.*

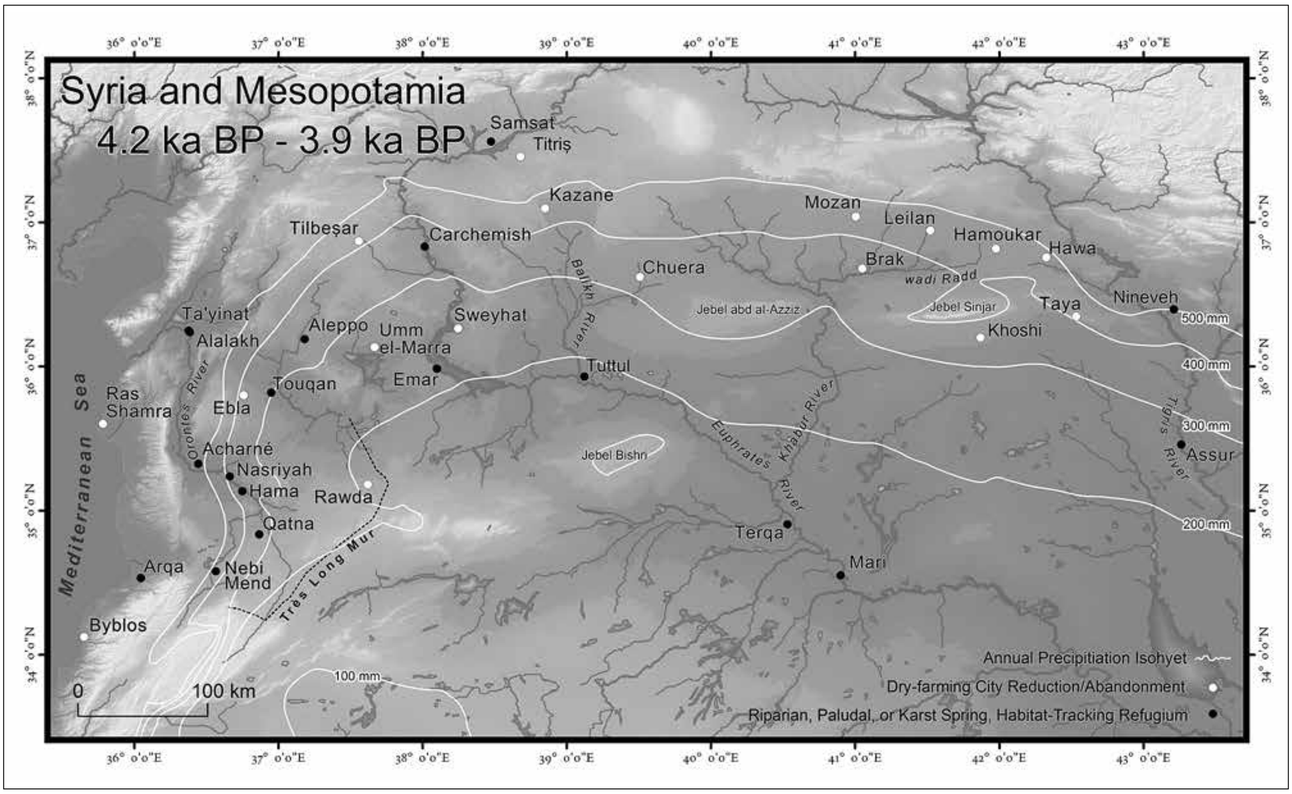


Fig. 10 Syria and Mesopotamia, 4.2–3.9 ka BP. West Asian settlement reductions and abandonments in rain-fed terrains, and riparian, paludal, and karst spring habitat-tracking refugia. The »Très Long Mur« protected the new karst spring Orontes River urban refugia from »Amorite« nomad incursions much as did its contemporary analogue »The Repeller-of-the-Amorites Wall« in southern Mesopotamia.

Abb. 10 *Syrien und Mesopotamien, 4,2–3,9 ka BP. Rückgang der Besiedlung Westasiens und Verlassen von nicht bewässerten Gebieten sowie die Verlagerung in Fluss-, Sumpf- und Karstquellenregionen. Die »sehr lange Mauer« bot den neuen urbanen Zufluchtstätten an den Karstquellen des Orontes Flusses Schutz gegen Einfälle durch »amoritische« Nomadenpopulationen; dieselbe Funktion erfüllte die gleichzeitige »Abwehrmauer gegen die Amoriten« in Südmesopotamien.*

plains, removed themselves as sedentary agriculturalists to riparian, paludal, and karstic refugia, others appear to have adopted pastoralism as a lower-energy adaptation to dry farming desertification. With the continuation of the 4.2 ka BP megadrought, these Hanaeans – that is, literally, pastoralists – were blocked from the seasonal Euphrates winter/Khabur Plains summer transhumance – known from the subsequent resettlement period's Mari archives –, and were pushed and pulled downstream into southern Mesopotamia by the enlarging consumption of riverside forage, as in the 1930s droughts (Boucheman 1934). Although this appears a logical reconstruction, the archaeological and epigraphic data remain limited and a target for future documentation and amplification. Nomadisation as a societal response to megadrought still remains difficult to quantify, but nevertheless appears as a response to similar circumstances elsewhere, as during the Tiwanaku megadrought and collapse (Fig. 10; Dillehay/Kolata 2004).

Conclusions

Counterfactually, would regional abandonment have occurred without the 4.2 ka BP megadrought? Some accounts argue against a purported »environmental determinism« in view of the abruptness, magnitude, and duration of the 4.2 ka BP phenomenon. N. Roberts et al. (2011), for instance, see settlements that were not abandoned during this period, hence »successful adaptions«, although these adaptations are not described. In fact, however, sites that are cited as not collapsing, either did, in fact, collapse (e. g. Tell Brak and Rawda abandonments), or were located in riparian or karstic refugia (e. g. Mari on the Euphrates River and Qatna on the Orontes River). A similar error clouds observations that posit an isotropic Syria (e. g. Schwartz 2007), and thereby miss the geographical and hydrological variability that provided habitat-tracking refugia along the karstic spring-fed Orontes River and along the central and southern Euphrates River, supplying irrigation agriculture.

The collapse and abandonment of Akkadian imperialised Khabur Plains settlement, and adjacent dry farming domains in the Aegean and West Asia, were a function of 4.2–3.9 ka BP megadrought abruptness (onset over less than five years), magnitude (30–50 % precipitation reduction) and duration (200–300 years) that reduced dry farming agriculture. In the absence of available technological innovation or regional subsistence relief, the region-wide societal adaptations were collapse, abandonment, habitat-tracking to agricultural refugia, and nomadisation.

The abrupt return of a pre-4.2 ka BP annual precipitation returned dry farming to the Khabur Plains and the West Syrian plains around Aleppo and Idlib, as well as to Palestine, Anatolia, and the Aegean. In Mesopotamia, the resettlement of formerly arid and abandoned territories was the last stage of »Amoritisation«, the sedentarisation of the Amorite/Hanaean pastoral nomads, dramatically recorded in their archaeologically retrieved settlements within the Leilan region survey (Ristvet/Weiss 2013) and well recorded epigraphically, which led thereafter to the military struggles for control of newly opened lands and agricultural wealth during the 19th century BC and 18th century BC that initiated the succeeding Middle Bronze Age. While the physical return of dry farming lands is now clear, the social forces behind this opportunistic resettlement remain to be explored.

The steppic, riparian, paludal, and karstic resources of West Asia were thus fully utilised for the abrupt social and environmental interactions at the 4.2–3.9 ka BP megadrought. Demographic and social resilience across the West Asian landscapes were achieved by adaptive political collapse, regional abandonment, nomadisation, and habitat-tracking to sustainable agricultural refugia.

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Bibliography

Almamori 2014
H. O. Almamori, Gišša (Umm al-Aqarib), Umma (Jokha) and Lagaš in the Early Dynastic III Period. Al-Rāfidān 35, 2014, 1–38.

Al-Maqdissi 2010
M. Al-Maqdissi, Matériel pour l'étude de la ville en Syrie (deuxième partie) (Urban planning in Syria during the SUR [Second Urban Revolution]). In: K. Ohnuma (ed.) Formation of Tribal Communities: Integrated Research in the Middle Euphrates, Syria. Papers presented at a symposium held in Tokyo, Nov. 21–23, 2009 (Tokyo 2010) 131–145.

Arrivabeni 2012
M. Arrivabeni, Post-Akkadian Settlement Distribution in the Leilan Region Survey. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 261–278.

Arz et al. 2006
H. W. Arz/F. Lamy/J. Pätzold, A pronounced dry event recorded around 4.2 ka in brine sediments from the northern Red Sea. Quaternary Research 66,3, 2006, 432–441.

Baffi/Peyronel 2013
F. Baffi/L. Peyronel, Early Bronze Age Phases at Tell Tuqan. In: P. Matthiae/N. Marchetti (eds.), Ebla and its Landscape: Early State Formation in the Ancient Near East (Walnut Creek 2013) 195–214.

Baker et al. 2009
P. A. Baker/S. C. Fritz/S. J. Burns/E. Ekdahl/C. A. Rigsby, The nature and origin of decadal to millennial scale climate variability in the southern tropics of South America: the Holocene record of Lago Umayo, Peru. In: F. Vimeux/F. Sylvestre/M. Khodri (eds.), Past Climate Variability in South America and Surrounding Regions: From the Last Glacial Maximum to the Holocene (Dordrecht 2009) 301–322.

Bar-Matthews/Ayalon 2011
M. Bar-Matthews/A. Ayalon, Mid-Holocene climate variations revealed by high-resolution speleothem records from Soreq Cave, Israel and their correlation with cultural changes. Holocene 21,1, 2011, 163–171.

Barge et al. 2014
O. Barge/C. Castel/J. Élie Brochier, Human impact on the landscape around Al-Rawda (Syria) during the Early Bronze IV: evidence for exploitation, occupation and appropriation of the land. In: D. Morandi Bonacossi (ed.) Settlement Dynamics and Human-Landscape Interaction in the Dry Steppes of Syria. Stud. Chaburensia 4 (Wiesbaden 2014) 173–185.

Baruch/Bottema 1999
U. Baruch/S. Bottema, A new pollen diagram from Lake Hula: vegetational, climatic and anthropogenic implications. In: H. Kawanabe/G. W. Coulter/A. C. Roosevelt (eds.), Ancient Lakes: Their Cultural and Biological Diversity (Ghent 1999) 75–86.

Berkelhammer et al. 2012
M. Berkelhammer/A. Sinha/L. Stott/H. Cheng/F. S. R. Pausata/K. Yoshimura, An abrupt shift in the Indian monsoon 4000 years ago. In: L. Giosan/D. Q. Fuller/K. Nicoll/R. K. Flad/P. D. Clift (eds.), Climates, Landscapes, and Civilizations. Geophysical Monogr. Ser. 198 (Washington DC 2012) 75–87.

Bernhardt et al. 2012
C. E. Bernhardt/B. P. Horton/J.-D. Stanley, Nile Delta vegetation response to Holocene climate variability. Geology 40,7, 2012, 615–618, doi:10.1130/G33012.1.

Black et al. 2004
J. A. Black/G. Cunningham/E. Robson/G. Zólyomi, The Literature of Ancient Sumer (Oxford 2004).

Blair et al. 2015
C. L. Blair/Á. Geirsdóttir/G. H. Miller, A high-resolution multi-proxy lake record of Holocene environmental change in southern Iceland. Journal Quaternary Scien. 30,3, 2015, 281–292, doi:10.1002/jqs.2780.

Booth et al. 2005
R. K. Booth/S. T. Jackson/S. L. Forman/J. E. Kutzbach/E. A. Bettis III/J. Kreig/D. K. Wright, A severe centennial-scale drought in midcontinental North America 4200 years ago and apparent global linkages. Holocene 15, 2005, 321–328.

Bottema 1997
S. Bottema, Third Millennium Climate in the Near East Based upon Pollen Evidence. In: H. N. Dalfes/G. Kukla/H. Weiss (eds.), Third Millennium BC Climate Change and Old World Collapse. Proceedings of the NATO Advanced Research Workshop on Third Millennium BC Climate Change and Old World Collapse, held at Kemer, Turkey, September 19–24, 1994. NATO Advanced Stud. Inst. Ser. I. Global Environmental Change 49 (Berlin 1997) 489–515.

Bottema et al. 2001
S. Bottema/H. Woldring/I. Kayan, The Late Quaternary vegetation history of western Turkey. In: J. J. Roodenberg/L. C. Thissen (eds.), The Ilıpınar Excavations 2. Uitgaven Nederland Hist.-Arch. Inst Istanbul 93 (Leiden 2001) 327–354.

Boucheman 1934
A. de Boucheman, La sédentarisation des nomades du désert de Syrie. L'Asie française 320, 1934, 140–143.

Boyer et al. 2006
P. Boyer/N. Roberts/D. Baird, Holocene environment and settlement on the Çarşamba alluvial fan, south-central Turkey: Integrating geoarchaeology and archaeological field survey. Geoarchaeology 21,7, 2006, 675–698, doi:10.1002/gea.20133.

Brisset et al. 2013
E. Brisset/C. Miramont/F. Guiter/E. J. Anthony/K. Tachikawa/J. Poulenard/F. Arnaud/C. Delhon/J.-D. Meunier/E. Bard/F. Suméra Non-reversible geosystem destabilisation at 4200 cal. BP: Sedimentological, geochemical and botanical markers of soil erosion recorded in a Mediterranean alpine lake. Holocene 23,12, 2013, 1863–1874, doi:10.1177/0959683613508158.

Brumfield 2013
S. Brumfield, Imperial Methods: Using Text Mining and Social Network Analysis to Detect Regional Strategies in the Akkadian Empire. Unpubl. Diss. Univ. California (Los Angeles 2013).

Buccellati/Kelly-Buccellati 2000
G. Buccellati/M. Kelly-Buccellati, The Royal Palace of Urkesh. Report on the 12th Season at Tell Mozan/Urkesh: Excavations in Area AA, June–October 1999. Mitt. Dt. Orient-Ges. 132, 2000, 133–183.

Butterlin 2007
P. Butterlin, Mari, les šakkanakku et la crise de la fin du troisième millénaire. In: C. Kuzucuoğlu/C. Marro (eds.), Sociétés humaines et changement climatique à la fin du troisième millénaire: une crise a-t-elle eu lieu en Haute Mésopotamie? Actes du colloque de Lyon, 5–8 décembre 2005. Varia Anatolica 19 (Istanbul 2007) 227–245.

Cai et al. 2010
Y. Cai/L. Tan/H. Cheng/Z. An/R. L. Edwards/M. J. Kelly/X. Kong/X. Wang, The variation of summer monsoon precipitation in central China since the last deglaciation. Earth

Planetary Scien. Letters 291,1–4, 2010, 21–31.
Carrión et al. 2003
J. S. Carrión/P. Sánchez-Gómez/J. F. Mota/R. Yll/C. Chaín, Holocene vegetation dynamics, fire and grazing in the Sierra de Gádor, southern Spain. Holocene 13,6, 2003, 839–849, doi:10.1191/0959683603hl662rp.
Colantoni 2012
C. Colantoni, Touching the void: The Post-Akkadian Period viewed from Tell Brak. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 45–64.
Coope 1979
G. R. Coope, Late Cenozoic Fossil Coleoptera: Evolution, Biogeography, and Ecology. Annu. Rev. Ecology Systematics 10, 1979, 247–267.
Cordova/Lehman 2005
C. E. Cordova/P. H. Lehman, Holocene environmental change in southwestern Crimea (Ukraine) in pollen and soil records. Holocene 15,2, 2005, 263–277, doi:10.1191/0959683605hl791rp.
Cullen et al. 2000
H. M. Cullen/P. B. deMenocal/S. Hemming/G. Hemming/F. H. Brown/T. Guilderson/F. Sirocko, Climate Change and the Collapse of the Akkadian Empire: Evidence from the Deep Sea. Geology 28,4, 2000, 379–382.
Cullen et al. 2002
H. M. Cullen/A. Kaplan/P. A. Arkin/P. B. deMenocal, Impact of the North Atlantic Oscillation on Middle Eastern Climate and Streamflow. Climatic Change 55,3, 2002, 315–338, doi:10.1023/A:1020518305517.
D'Andrea 2012
M. D'Andrea, The Early Bronze IV Period in South-Central Transjordan: Reconsidering Chronology Through Ceramic Technology. Levant 44,1, 2012, 17–50, doi:10.1179/175638012X13285409187838.
Davis 2013
J. L. Davis, »Minding the Gap«: A Problem in Eastern Mediterranean Chronology, Then and Now. Am. Journal Arch. 117,4, 2013, 527–533.
Dean 1997
W. E. Dean, Rates, timing, and cyclicity of Holocene Eolian activity in north-central United States: evidence from varvd lake sediments. Geology 25,4, 1997, 331–334.
Di Rita/Magri 2009
F. Di Rita/D. Magri, Holocene drought, deforestation and evergreen vegetation development in the central Mediterranean: a 5500 year record from Lago Alimini Piccolo, Apulia, southeast Italy. Holocene 19,2, 2009, 295–306, doi:10.1177/0959683608100574.
Dillehay/Kolata 2004
T. D. Dillehay/A. L. Kolata, Long-term human response to uncertain environmental conditions in the Andes. Proc. Nat. Acad. Scien. 101,12, 2004, 4325–4330, doi:10.1073/pnas.0400538101.
Dixit et al. 2014
Y. Dixit/D. A. Hodell/C. A. Petrie, Abrupt weakening of the summer monsoon in northwest India ~4100 yr ago. Geology 42,4, 2014, 339–342, doi:10.1130/G35236.1.
Djamali et al. 2009
M. Djamali/J.-L. De Beaulieu/N. F. Miller/V. Andrieu-Ponel/P. Ponel/R. Lak/N. Sadeddin/H. Akhani/H. Fazeli, Vegetation history of the SE section of the Zagros Mountains during the last five millennia; a pollen record from the Maharlou Lake, Fars Province, Iran. Vegetation Hist. Archaeobotany 18,2, 2009, 123–136, doi:10.1007/s00334-008-0178-2.
Drysdale et al. 2006
R. Drysdale/G. Zanchetta/J. Hellstrom/R. Maas/A. Fallick/M. Pickett/I. Cartwright/L. Piccini, Late Holocene drought responsible for the collapse of Old World civilizations is recorded in an Italian cave flowstone. Geology 34,2, 2006, 101–104, doi:10.1130/G22103.1.
Dykoski et al. 2005
C. A. Dykoski/R. L. Edwards/H. Cheng/D. Yuan/Y. Cai/M. Zhang/Y. Lin/J. Qing/Z. An/J. Revenaugh, A high resolution, absolute-dated Holocene and deglacial Asian monsoon record from Dongge Cave, China. Earth Planetary Scien. Letters 233,1–2, 2005, 71–86, doi:10.1016/j.epsl.2005.01.036.
Eastwood et al. 1999
W. J. Eastwood/N. Roberts/H. F. Lamb/J. C. Tibby, Holocene environmental change in southwest Turkey: a palaeoecological record of lake and catchment-related changes. Quaternary Scien. Rev. 18,4–5, 1999, 671–695, doi:10.1016/S0277-3791(98)00104-8.
Eastwood et al. 2007
W. J. Eastwood/M. J. Leng/N. Roberts/B. Davis, Holocene climate change in the eastern Mediterranean region: a comparison of stable isotope and pollen data from Lake Gölhisar, southwest Turkey. Journal Quaternary Scien. 22,4, 2007, 327–341, doi:10.1002/jqs.1062.
Edelman-Furstenberg et al. 2009
Y. Edelman-Furstenberg/A. Almogi-Labin/C. Hemleben, Palaeoceanographic evolution of the central Red Sea during the late Holocene. Holocene 19,1, 2009, 117–127, doi:10.1177/0959683608098955.
Ehrmann et al. 2007
W. Ehrmann/G. Schmiedl/Y. Hamann/T. Kuhnt/C. Hemleben/W. Siebel, Clay minerals in late glacial and Holocene sediments of the northern and southern Aegean Sea. Palaeogeography, Palaeoclimatology, Palaeoecology 249,1–2, 2007, 36–57, doi:10.1016/j.palaeo.2007.01.004.
Eldredge 1985
N. Eldredge, Time Frames: The Evolution of Punctuated Equilibria (Princeton 1985).
Emberling et al. 2012
G. Emberling/H. McDonald/J. Weber/H. Wright, After Collapse: The Post-Akkadian Occupation in the Pisé Building, Tell Brak. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 65–88.
FAO 1966
Food and Agriculture Organization of the United Nations, Étude des Ressources en Eaux Souterraines de la Jazireh Syrienne (Rome 1966).
Finkelstein 1966
J. J. Finkelstein, The Genealogy of the Hammurapi Dynasty. Journal Cuneiform Stud. 20,3–4, 1966, 95–118, doi:10.2307/1359643.
Fisher 2011
D. A. Fisher, Connecting the Atlantic-sector and the north Pacific (Mt Logan) ice core stable isotope records during the Holocene: The role of El Niño. Holocene 21,7, 2011, 1117–1124, doi:10.1177/0959683611400465.
Fleitmann et al. 2003
D. Fleitmann/S. J. Burns/M. Mudelsee/U. Neff/J. Kramers/A. Mangini/A. Matter, Holocene Forcing of the Indian Monsoon Recorded in a Stalagmite from Southern Oman. Science 300,5626, 2003, 1737–1739, doi:10.1126/science.1083130.
Foster 2011
B. R. Foster, The Sargonic Period: Two Historiographical Problems. In: G. Barjamovic/J. L. Dahl/U. S. Koch/W. Sommerfeld/J. G. Westenholz (eds.), Akkade is King. A Collection of Papers by Friends and Colleagues presented to Aage Westenholz on the occasion of his 70th birthday 15thh of May 2009. Uitgaven Nederland Inst. Nabije Oosten Leiden 118 (Leiden 2011) 127–137.
Francke et al. 2013
A. Francke/B. Wagner/M. J. Leng/J. Rethemeyer, A Late Glacial to Holocene record of environmental change from Lake Dojran (Macedonia, Greece). Climate Past 9, 2013, 481–498, doi:10.5194/cp-9-481-2013.
Frumkin 2009
A. Frumkin, Stable isotopes of a subfossil Tamarix tree from the Dead Sea region, Israel, and their implications for the Intermediate Bronze Age environmental crisis. Quaternary Research 71,3, 2009, 319–328, doi:10.1016/j.yqres.2009.01.009.
Gasche 1990
Reallexikon der Assyriologie und vorderasiatischen Archäologie 7 (1990) 591–595 s. v. Mauer (H. Gasche).
Gasse 2000
F. Gasse, Hydrological changes in the African tropics since the Last Glacial Maximum. Quaternary Scien. Rev. 19,1, 2000, 189–211, doi:10.1016/S0277-3791(99)00061-X.
Geirsdóttir et al. 2013
Á. Geirsdóttir/G. H. Miller/D. J. Larsen/S. Ólafsdóttir, Abrupt Holocene climate transitions in the northern North Atlantic region recorded by synchronized lacustrine records in Iceland. Quaternary Scien. Rev. 70, 2013, 48–62, doi:10.1016/j.quascirev.2013.03.010.
Gelb 1961
I. J. Gelb Old Akkadian Writing and Grammar2. Mat. Assyrian Dictionary 2 (Chicago 1961).
Geyer et al. 2010
B. Geyer/N. Awad/M. Al-Dbiyat/Y. Calvet/M.-O. Rousset, Un »très long mur« dans la steppe syrienne. Paléorient 36,2, 2010, 57–72, doi:10.3406/paleo.2010.5388.
Gibson 2001
M. Gibson, Hamoukar. Oriental Inst. Annu. Report 2000–2001 (2001) 77–83.
Glassner 1986
J.-J. Glassner, La chute d'Akkadé. L'événement et sa mémoire. Berliner Beitr. Vorderer Orient 5 (Berlin 1986).
Glassner 1993
J.-J. Glassner, Chroniques mésopotamiennes. Roue à livres 19 (Paris 1993).
Glassner/2004
J.-J. Glassner, Mesopotamian Chronicles. Writings Ancient World 19 (Atlanta 2004).
Göktürk 2011
O. M. Göktürk, Climate in the Eastern Mediterranean through the Holocene inferred from Turkish stalagmites. Unpubl. Diss. Bern University (Bern 2011).
Grayson 1987
A. K. Grayson, Assyrian Rulers of the Third and Second Millennia BC (to 1115). Royal Inscriptions Mesopotamia, Assyrian Periods 1 (Toronto 1987).
Haenssler et al. 2014
E. Haenssler/I. Unkel/W. Dörfler/M.-J. Nadeau, Driving mechanisms of Holocene lagoon development and barrier accretion in Northern Elis, Peloponnese, inferred from the sedimentary record of the Kotychi Lagoon. Quaternary Scien. Journal 63,1, 2014, 60–77, doi:10.3285/eg.63.1.04.
Haiman 1996
M. Haiman, Early Bronze Age IV Settlement Pattern of the Negev and Sinai Deserts: View from Small Marginal Temporary Sites. Bull. Am. Schools Orient. Research 303, 1996, 1–32, doi:10.2307/1357468.

Hardt et al. 2010
B. Hardt/H. D. Rowe/G. S. Springer/H. Cheng/R. L. Edwards, The seasonality of east central North American precipitation based on three coeval Holocene speleothems from southern West Virginia. Earth Planetary Scien. Letters 295,3–4, 2010, 342–348, doi:10.1016/j.epsl.2010.04.002.
Harrison 2012
T. P. Harrison, The Southern Levant. In: D. T. Potts (ed.), A Companion to the Archaeology of the Ancient Near East (Malden 2012) 629–646.
Hassan et al. 2006
F. Hassan/G. Tassie/R. Flower/M. Hughes/M. Hamden, Modelling environmental and settlement change in the Fayum. Egyptian Arch. 29, 2006, 37–40.
Heimpel 2003
W. Heimpel, Letters to the King of Mari. Mesopotamian Civilizations Ser. 12 (Winona Lake 2003).
Høyrup 2014
J. Høyrup, Written Mathematical Traditions in Ancient Mesopotamia: Knowledge, ignorance, and reasonable guesses. In: D. Bawanypeck/A. Imhausen (eds.), Traditions of Written Knowledge in Ancient Egypt and Mesopotamia. Proceedings of Two Workshops Held at Goethe-University, Frankfurt/Main in December 2011 and May 2012. Alter Orient u. Altes Testament 403 (Münster 2014) 189–214.
Jahns 1993
S. Jahns, On the Holocene vegetation history of the Argive Plain (Peloponnese, southern Greece). Vegetation Hist. Archaeobotany 2,4, 1993, 187–203, doi:10.1007/BF00198161.
Jiménez-Moreno/Anderson 2012
G. Jiménez-Moreno/R. S. Anderson, Holocene vegetation and climate change recorded in alpine bog sediments from the Borreguiles de la Virgen, Sierra Nevada, southern Spain. Quaternary Research 77,1, 2012, 44–53, doi:10.1016/j.yqres.2011.09.006.
Jiménez-Moreno et al. 2015
G. Jiménez-Moreno/A. Rodríguez-Ramírez/J. N. Pérez-Asensio/J. S. Carrión/J. A. López-Sáez/J. J. R. Villarías-Robles/S. Celestino-Pérez/E. Cerrillo-Cuenca/Á. León/C. Contreras, Impact of late-Holocene aridification trend, climate variability and geodynamic control on the environment from a coastal area in SW Spain. Holocene 25,4, 2015, 607–617, doi:10.1177/0959683614565955.
Kaniewski et al. 2008
D. Kaniewski/E. Paulissen/E. Van Campo/M. al-Maqdissi/J. Bretschneider/K. Van Lerberghe, Middle East coastal ecosystem response to middle-to-late Holocene abrupt climate changes. Proc. Nat. Acad. Scien. 105,37, 2008, 13941–13946, doi:10.1073/pnas.0803533105.
Kaniewski et al. 2013
D. Kaniewski/E. Van Campo/J. Guiot/S. Le Burel/T. Otto/C. Baeteman, Environmental Roots of the Late Bronze Age Crisis. Pub. Library Scien. ONE 8,8, 2013, 1–10, doi:10.1371/journal.pone.0071004.
Kaniewski et al. 2013a
D. Kaniewski/E. Van Campo/C. Morhange/J. Guiot/D. Zviely/I. Shaked/T. Otto/M. Artzy, Early urban impact on Mediterranean coastal environments. Nature Scien. Reports 3, 2013, 3540, doi:10.1038/srep03540.
Kröpelin et al. 2008
S. Kröpelin/D. Verschuren/A.-M. Lézine/H. Eggermont/C. Cocquyt/P. Francus/J.-P. Cazet/M. Fagot/B. Rumes/J. M. Russell/F. Darius/D. J. Conley/M. Schuster/H. von Suchodoletz/D. R. Engstrom, Climate-Driven Ecosystem Succession in the Sahara: The Past 6000 Years. Science 320,5877, 2008, 765–768, doi:10.1126/science.1154913.
Kuhnt et al. 2008
T. Kuhnt/G. Schmiedl/W. Ehrmann/Y. Hamann/N. Andersen, Stable isotopic composition of Holocene benthic foraminifers from the Eastern Mediterranean Sea: Past changes in productivity and deep water oxygenation. Palaeogeography, Palaeoclimatology, Palaeoecology 268,1–2, 2008, 106–115, doi:10.1016/j.palaeo.2008.07.010.
Kushnir/Stein 2010
Y. Kushnir/M. Stein, North Atlantic influence on 19th–20th century rainfall in the Dead Sea watershed, teleconnections with the Sahel, and implication for Holocene climate fluctuations. Quaternary Scien. Rev. 29,27–28, 2010, 3843–3860, doi:10.1016/j.quascirev.2010.09.004.
Kuzucuoğlu et al. 2011
C. Kuzucuoğlu/W. Dörfler/S. Kunesch/F. Goupille, Mid- to late-Holocene climate change in central Turkey: The Tecer Lake record. Holocene 21,1, 2011, 173–188, doi:10.1177/0959683610384163.
Langgut et al. 2014
D. Langgut/F. H. Neumann/M. Stein/A. Wagner/E. J. Kagan/E. Boaretto/I. Finkelstein, Dead Sea pollen record and history of human activity in the Judean Highlands (Israel) from the Intermediate Bronze into the Iron Ages (~2500–500 BCE). Palynology 38,2, 2014, 280–302, doi:10.1080/01916122.2014.906001.
Lemcke/Sturm 1997
G. Lemcke/M. Sturm, δ^{18}o and trace element measurements as proxy for the reconstruction of climate changes at Lake Van (Turkey): preliminary results. In: H. N. Dalfes/G. Kukla/H. Weiss (eds.), Third Millennium BC Climate Change and Old World Collapse. Proceedings of the NATO Advanced Research Workshop on Third Millennium BC Climate Change and Old World Collapse, held at Kemer, Turkey, September 19–24, 1994, NATO Advanced Stud. Inst. Ser. I. Global Environmental Change 49 (Berlin 1997) 653–678.
Leng et al. 1999
M. J. Leng/N. Roberts/J. M. Reed/H. J. Sloane, Late Quaternary palaeohydrology of the Konya Basin, Turkey, based on isotope studies of modern hydrology and lacustrine carbonates. Journal Paleolimnology 22,2, 1999, 187–204, doi:10.1023/A:1008024127346.
Leng et al. 2010
M. J. Leng/I. Baneschi/G. Zanchetta/C. N. Jex/B. Wagner/H. Vogel, Late Quaternary palaeoenvironmental reconstruction from Lakes Ohrid and Prespa (Macedonia/Albania border) using stable isotopes. Biogeosciences 7, 2010, 3109–3122, doi:10.5194/bg-7-3109-2010.
Leroy et al. 2007
S. A. G. Leroy/F. Marret/E. Gibert/F. Chalié/J.-L. Reyss/K. Arpe, River inflow and salinity changes in the Caspian Sea during the last 5500 years. Quaternary Scien. Rev. 26,25–28, 2007, 3359–3383, doi:10.1016/j.quascirev.2007.09.012.
Leroy et al. 2014
S. A. G. Leroy/L. López-Merino/A. Tudryn/F. Chalié/F. Gasse, Late Pleistocene and Holocene palaeoenvironments in and around the middle Caspian basin as reconstructed from a deep-sea core. Quaternary Scien. Rev. 101, 2014, 91–110, doi:10.1016/j.quascirev.2014.07.011.
Lézine 2009
A.-M. Lézine, Timing of vegetation changes at the end of the Holocene Humid Period in desert areas at the northern edge of the Atlantic and Indian monsoon systems. Comptes Rendus Geoscien. 341,8–9, 2009, 750–759, doi:10.1016/j.crte.2009.01.001.
Li et al. 2007
Y.-X. Li/Z. Yu/K. P. Kodama, Sensitive moisture response to Holocene millennial-scale climate variations in the Mid-Atlantic region, USA. Holocene 17,1, 2007, 3–8, doi:10.1177/0959683606069386.
Licciardi et al. 2009
J. M. Licciardi/J. M. Schaefer/J. R. Taggart/D. C. Lund, Holocene Glacier Fluctuations in the Peruvian Andes Indicate Northern Climate Linkages. Science 326, 2009, 1677–1679.
Lillis Forrest et al. 2007
F. de Lillis Forrest/L. Milano/L. Mori, The Akkadian Occupation in the Northwest Area of the Tell Leilan Acropolis. Kaskal 4, 2007, 43–64.
Lionello et al. 2006
P. Lionello/P. Malanotte-Rizzoli/R. Boscolo (eds.), Mediterranean Climate Variability. Developments Earth and Environmental Scien. 4 (Amsterdam 2006).
Liu et al. 2010
F. Liu/Y. Zhang/Z. Feng/G. Hou/Q. Zhou/H. Zhang, The impacts of climate change on the Neolithic cultures of Gansu-Qinghai region during the late Holocene Megathermal. Journal Geogr. Scien. 20, 2010, 417–430.
Lu et al. 2015
R. Lu/F. Jia/S. Gao/Y. Shang/J. Li/C. Zhao, Holocene aeolian activity and climatic change in Qinghai Lake basin, northeastern Qinghai-Tibetan Plateau. Palaeogeography, Palaeoclimatology, Palaeoecology 430, 2015, 1–10, doi:10.1016/j.palaeo.2015.03.044.
Magny et al. 2007
M. Magny/J.-L. de Beaulieu/R. Drescher-Schneider/B. Vannière/A.-V. Walter-Simonnet/Y. Miras/L. Millet/G. Bossuet/O. Peyron/E. Brugiapaglia/A. Leroux, Holocene climate changes in the central Mediterranean as recorded by lake-level fluctuations at Lake Accesa (Tuscany, Italy). Quaternary Scien. Rev. 26,13–14, 2007, 1736–1758, doi:10.1016/j.quascirev.2007.04.014.
Magny et al. 2009
M. Magny/B. Vannière/G. Zanchetta/E. Fouache/G. Touchais/L. Petrika/C. Coussot/A.-V. Walter-Simonnet/F. Arnaud, Possible complexity of the climatic event around 4300–3800 cal. BP in the central and western Mediterranean. Holocene 19,6, 2009, 823–833, doi:10.1177/0959683609337360.
Magny et al. 2011
M. Magny/B. Vannière/C. Calo/L. Millet/A. Leroux/O. Peyron/G. Zanchetta/T. La Mantia/W. Tinner, Holocene hydrological changes in south-western Mediterranean as recorded by lake-level fluctuations at Lago Preola, a coastal lake in southern Sicily, Italy. Quaternary Scien. Rev. 30,19–20, 2011, 2459–2475, doi:10.1016/j.quascirev.2011.05.018.
Magri/Parra 2002
D. Magri/I. Parra, Late Quaternary western Mediterranean pollen records and African winds. Earth Planetary Scien. Letters 200,3–4, 2002, 401–408, doi:10.1016/S0012-821X(02)00619-2.
Magri/Sadori 1999
D. Magri/L. Sadori, Late Pleistocene and Holocene pollen stratigraphy at Lago di Vico, central Italy. Vegetation History and Archaeobotany 8,4, 1999, 247–260, doi:10.1007/BF01291777.
Mallowan 1947
M. E. L. Mallowan, Excavations at Brak and Chagar Bazar. Iraq 9, 1947, 1–259.

Marchant/Hooghiemstra 2004
R. Marchant/H. Hooghiemstra, Rapid environmental change in Africa and South American tropics around 4000 years before present: a review. Earth Scien. Rev. 66,3–4, 2004, 217–260, doi:10.1016/j.earscirev.2004.01.003.
Marshall et al. 2011
M. H. Marshall/H. F. Lamb/D. Huws/S. J. Davies/R. Bates/J. Bloemendal/J. Boyle/M. J. Leng/M. Umer/C. Bryant, Late Pleistocene and Holocene drought events at Lake Tana, the source of the Blue Nile. Global and Planetary Change 78,3–4, 2011, 147–161, doi:10.1016/j.gloplacha.2011.06.004.
Masi et al. 2013
A. Masi/L. Sadori/G. Zanchetta/I. Baneschi/M. Giardini, Climatic interpretation of carbon isotope content of mid-Holocene archaeological charcoals from eastern Anatolia. Quaternary Internat. 303, 2013, 64–72, doi:10.1016/j.quaint.2012.11.010.
Matthiae 2013
P. Matthiae, The 3rd millennium in north-western Syria: Stratigraphy and architecture. In: M. Al-Maqdissi/P. Matthiae/W. Orthmann (eds.), Archéologie et Histoire de la Syrie 1. La Syrie de l'époque néolithique à l'âge du fer. Schr. Vorderasiat. Arch. 1,1 (Wiesbaden 2013) 181–198.
Mazzini et al. 2015
I. Mazzini/E. Gliozzi/R. Koci/I. Soulie-Märsche/G. Zanchetta/I. Baneschi/L. Sadori/M. Giardini/A. Van Welden/S. Bushati, Historical evolution and Middle to Late Holocene environmental changes in Lake Shkodra (Albania): New evidences from micropaleontological analysis. Palaeogeography, Palaeoclimatology, Palaeoecology 419, 2015, 47–59, doi:10.1016/j.palaeo.2014.08.012.
McCarthy 2012
A. McCarthy, The End of Empire: Akkadian and Post-Akkadian glyptic in the Jezirah, the evidence from Tell Leilan in context. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 217–224.
McDonald/Jackson 2003
H. McDonald/N. Jackson, A house on the hill: second millennium investigations—the Middle Bronze Age. In: R. Matthews (ed.), Excavations at Tell Brak 4. Exploring an Upper Mesopotamian Regional Centre, 1994–1996 (Cambridge 2003) 271–320.
Menounos et al. 2008
B. Menounos/J. J. Clague/G. Osborn/B. H. Luckman/T. R. Lakeman/R. Minkus, Western Canadian glaciers advance in concert with climate change circa 4.2 ka. Geophysical Research Letters 35,7, 2008, L07501, doi:10.1029/2008GL033172.
Merrill et al. 2009
W. L. Merrill/R. J. Hard/J. B. Mabry/G. J. Fritz/K. R. Adams/J. R. Roney/A. C. MacWilliams, The diffusion of maize to the southwestern United States and its impact. Proc. Nat. Acad. Scien. 106,50, 2009, 21019–21026.
Migowski et al. 2006
C. Migowski/M. Stein/S. Prasad/J. F. W. Negendank/A. Agnon, Holocene climate variability and cultural evolution in the Near East from the Dead Sea sedimentary record. Quaternary Research 66,3, 2006, 421–431, doi:10.1016/j.yqres.2006.06.010.
Morandi Bonacossi 2009
D. Morandi Bonacossi, Tell Mishrife and its region during the EB IV and the EBA–MBA transition: a first assessment. In: P. J. Parr (ed.), The Levant in Transition: Proceedings of a Conference held at the British Museum on 20–21 April 2004. Palestine Explor. Fund Annu. 9 (Leeds 2009) 56–68.
Nicolle 2006
C. Nicolle, Tell Mohammed Diyab 3 (Paris 2006).
Ohnuma 2010
K. Ohnuma (ed.), Formation of Tribal Communities: Integrated Research in the Middle Euphrates, Syria. Papers presented at a symposium held in Tokyo, Nov. 21–23, 2009. Al-Rāfidān Special Issue 2010 (Tokyo 2010).
Olsen et al. 2012
J. Olsen/N. J. Anderson/M. F. Knudsen, Variability of the North Atlantic Oscillation over the past 5,200 years. Nature Geoscien. 5, 2012, 808–812, doi:10.1038/ngeo1589.
Parker/Goudie 2008
A. G. Parker/A. S. Goudie, Geomorphological and palaeoenvironmental investigations in the southeastern Arabian Gulf region and the implication for the archaeology of the region. Geomorphology 101,3, 2008, 458–470, doi:10.1016/j.geomorph.2007.04.028.
Parker et al. 2006
A. G. Parker/A. S. Goudie/S. Stokes/K. White/M. J. Hodson/M. Manning/D. Kennet, A record of Holocene climate change from lake geochemical analyses in southeastern Arabia. Quaternary Research 66,3, 2006, 465–476.
Peyron et al. 2013
O. Peyron/M. Magny/S. Goring/S. Joannin/J.-L. de Beaulieu/E. Brugiapaglia/L. Sadori/G. Garfi/K. Kouli/C. Ioakim/N. Combourieu-Nebout, Contrasting patterns of climatic changes during the Holocene across the Italian Peninsula reconstructed from pollen data. Climate Past 9,3, 2013, 1233–1252, doi:10.5194/cp-9-1233-2013.
Pfälzner 2012
P. Pfälzner, The Question of Desurbanisation versus Reurbanisation of the Syrian Jazirah in the Late Third and Early Second Millennium BC. In: N. Laneri/P. Pfälzner/S. Valentini (eds.), Looking North: The Socioeconomic Dynamics of the Northern Mesopotamian and Anatolian Regions during the Late Third and Early Second Millennium BC. Stud. Urbanisierung Nordmesopotamien D1 (Wiesbaden 2012) 51–80.
Powell 1990
Reallexikon der Assyriologie und Vorderasiatischen Archäologie 7 (1990) 457–517 s. v. Maße und Gewichte (M. A. Powell).
Prasad et al. 2014
S. Prasad/A. Anoop/N. Riedel/S. Sarkar/P. Menzel/N. Basavaiah/R. Krishnan/D. Fuller/B. Plessen/B. Gaye/U. Röhl/H. Wilkes/D. Sachse/R. Sawant/M. G. Wiesner/M. Stebich, Prolonged monsoon droughts and links to Indo-Pacific warm pool: A Holocene record from Lonar Lake, central India. Earth and Planetary Scien. Letters 391, 2014, 171–182, doi:10.1016/j.epsl.2014.01.043.
Pustovoytov et al. 2007
K. Pustovoytov/K. Schmidt/H. Taubald, Evidence for Holocene environmental changes in the northern Fertile Crescent provided by pedogenic carbonate coatings. Quaternary Research 67,3, 2007, 315–327, doi:10.1016/j.yqres.2007.01.002.
P'yankova 1994
L. P'yankova, Central Asia in the Bronze Age: sedentary and nomadic cultures. Antiquity 68,259, 1994, 355–372.
Railsback et al. 2011
L. B. Railsback/F. Liang/J. R. Vidal Romaní/A. Grandal-d'Anglade/M. Vaqueiro Rodríguez/L. Santos Fidalgo/D. Fernández Mosquera/H. Cheng/R. L. Edwards, Petrographic and isotopic evidence for Holocene long-term climate change and shorter-term environmental shifts from a stalagmite from the Serra do Courel of northwestern Spain, and implications for climatic history across Europe and the Mediterranean. Palaeogeography, Palaeoclimatology, Palaeoecology 305,1–4, 2011, 172–184, doi:10.1016/j.palaeo.2011.02.030.
Ramsey et al. 2010
C. Bronk Ramsey/M. W. Dee/J. M. Rowland/T. F. G. Higham/S. A. Harris/F. Brock/A. Quiles/E. M. Wild/E. S. Marcus/A. J. Shortland, Radiocarbon-Based Chronology for Dynastic Egypt. Science 328,5985, 2010, 1554–1557, doi:10.1126/science.1189395.
Reed et al. 1999
J. M. Reed/N. Roberts/M. J. Leng, An evaluation of the diatom response to Late Quaternary environmental change in two lakes in the Konya Basin, Turkey, by comparison with stable isotope data. Quaternary Scien. Rev. 18,4–5, 1999, 631–646, doi:10.1016/S0277-3791(98)00101-2.
Regattieri et al. 2014
E. Regattieri/G. Zanchetta/R. N. Drysdale/I. Isola/J. C. Hellstrom/L. Dallai, Lateglacial to Holocene trace element record (Ba, Mg, Sr) from Corchia Cave (Apuan Alps, central Italy): paleoenvironmental implications. Journal Quaternary Scien. 29,4, 2014, 381–392, doi:10.1002/jqs.2712.
Revel et al. 2014
M. Revel/C. Colin/S. Bernasconi/N. Combourieu-Nebout/E. Ducassou/F. E. Grousset/Y. Rolland/S. Migeon/D. Bosch/P. Brunet/Y. Zhao/J. Mascle, 21,000 years of Ethiopian African monsoon variability recorded in sediments of the western Nile deep-sea fan. Regional Environmental Change 14,5, 2014, 1685–1696, doi:10.1007/s10113-014-0588-x.
Ristvet 2008
L. Ristvet, Legal and archaeological territories of the second millennium BC in northern Mesopotamia. Antiquity 82, 2008, 585–599.
Ristvet 2012
L. Ristvet, The Development of Underdevelopment? Imperialism, Economic Exploitation and Settlement Dynamics on the Khabur Plains, ca. 2300–2200 BC. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 241–261.
Ristvet/Weiss 2013
L. Ristvet/H. Weiss, The Ḫābūr Region in the Old Babylonian Period. In: M. Al-Maqdissi/P. Matthiae/W. Orthmann (eds.), Archéologie et Histoire de la Syrie 1. La Syrie de l'époque néolithique à l'âge du fer. Schr. Vorderasiat. Arch. 1,1 (Wiesbaden 2013) 257–272.
Roberts et al. 1999
N. Roberts/S. Black/P. Boyer/W. J. Eastwood/H. I. Griffiths/H. F. Lamb/M. J. Leng/R. Parish/J. M. Reed/D. Twigg/H. Yiğitbaşioğlu, Chronology and stratigraphy of Late Quaternary sediments in the Konya Basin, Turkey: Results from the KOPAL Project. Quaternary Scien. Rev. 18,4–5, 1999, 611–630, doi:10.1016/S0277-3791(98)00100-0.
Roberts et al. 2001
N. Roberts/J. M. Reed/M. J. Leng/C. Kuzucuoğlu/M. Fontugne/J. Bertaux/H. Woldring/S. Bottema/S. Black/E. Hunt/M. Karabiyikoğlu, The tempo of Holocene climatic change in the eastern Mediterranean region: new high-resolution crater-lake sediment data from central Turkey. Holocene 11,6, 2001, 721–736, doi:10.1191/09596830195744.
Roberts et al. 2011
N. Roberts/D. Brayshaw/C. Kuzucuoğlu/R. Perez/L. Sadori, The mid-Holocene climatic transition in the Mediterranean: Causes and

consequences. Holocene 21,1, 2011, 3–13, doi:10.1177/0959683610388058.
Sadori et al. 2013
L. Sadori/E. Ortu/O. Peyron/G. Zanchetta/B. Vannière/M. Desmet/M. Magny, The last 7 millennia of vegetation and climate changes at Lago di Pergusa (central Sicily, Italy). Climate Past 9,4, 2013, 1969–1984, doi:10.5194/cp-9-1969-2013.
Sadori et al. 2015
L. Sadori/M. Giardini/E. Gliozzi/I. Mazzini/R. Sulpizio/A. v. Welden/G. Zanchetta, Vegetation, climate and environmental history of the last 4500 years at lake Shkodra (Albania/Montenegro). Holocene 25,3, 2015, 435–444.
Sallaberger/Schrakamp 2015
W. Sallaberger/I. Schrakamp, Philological data for a historical chronology of Mesopotamia in the 3rd millennium. In: W. Sallaberger/I. Schrakamp (eds.), History & Philology. Associated Regional Chronologies Ancient Near East and Eastern Mediterranean 3 (Turnhout 2015) 1–136.
Salzer et al. 2014
M. W. Salzer/A. G. Bunn/N. E. Graham/M. K. Hughes, Five millennia of paleotemperature from tree-rings in the Great Basin, USA. Climate Dynamics 42,5–6, 2014, 1517–1526, doi:10.1007/s00382-013-1911-9.
Sandweiss et al. 2009
D. H. Sandweiss/R. S. Solís/M. E. Moseley/D. K. Keefer/C. R. Ortloff, Environmental change and economic development in coastal Peru between 5,800 and 3,600 years ago. Proc. Nat. Acad. Scien. 106,5, 2009, 1359–1363, doi:10.1073/pnas.0812645106.
Schettler et al. 2006
G. Schettler/Q. Liu/J. Mingram/M. Stebich/P. Dulski, East-Asian monsoon variability between 15000 and 2000 cal. yr BP recorded in varved sediments of Lake Sihailongwan (northeastern China, Long Gang volcanic field). Holocene 16, 2006, 1043–1057.
Schittek et al. 2015
K. Schittek/M. Forbriger/B. Mächtle/F. Schäbitz/V. Wennrich/M. Reindel/B. Eitel, Holocene environmental changes in the highlands of the southern Peruvian Andes (14° S) and their impact on pre-Columbian cultures. Climate Past 11, 2015, 27–44, doi:10.5194/cp-11-27-2015.
Schmidt et al. 2000
R. Schmidt/J. Müller/R. Drescher-Schneider/R. Krisai/K. Szeroczyńska/A. Barić, Changes in lake level and trophy at Lake Vrana, a large karstic lake on the Island of Cres (Croatia), with respect to palaeoclimate and anthropogenic impacts during the last approx. 16,000 years. Journal Limnology 59,2, 2000, 113–130.
Schmidt et al. 2011
A. Schmidt/M. Quigley/M. Fattahi/G. Azizi/M. Maghsoudi/H. Fazeli, Holocene settlement shifts and palaeoenvironments on the Central Iranian Plateau: Investigating linked systems. Holocene 21,4, 2011, 583–595, doi:10.1177/0959683610385961.
Schwartz 2007
G. M. Schwartz, Taking the long view on collapse: a Syrian perspective. In: C. Kuzucuoğlu/C. Marro (eds.), Sociétés humaines et changement climatique à la fin du troisième millénaire: une crise a-t-elle eu lieu en Haute Mésopotamie? Actes du Colloque de Lyon, 5–8 décembre 2005. Varia Anatolica 19 (Istanbul 2007) 45–67.
Schwartz et al. 2012
G. M. Schwartz/H. H. Curvers/S. S. Dunham/J. A. Weber, From urban origins to imperial integration in western Syria: Umm el-Marra 2006, 2008. Am. Journal Arch. 116,1, 2012, 157–193, doi: 10.3764/aja.116.1.0157.
Scussolini et al. 2011
P. Scussolini/T. Vegas-Vilarrúbia/V. Rull/J. P. Corella/B. L. Valero-Garcés/J. Gomà, Middle and late Holocene climate change and human impact inferred from diatoms, algae and aquatic macrophyte pollen in sediments from Lake Montcortès (NE Iberian Peninsula). Journal Paleolimnology 46,3, 2011, 369–385, doi:10.1007/s10933-011-9524-y.
Senior/Weiss 1992
L. Senior/H. Weiss, Tell Leilan »Sila-bowls« and the Akkadian reorganization of Subarian agricultural production. Orient-Express 2, 1992, 16–23.
Sommerfeld et al. 2004
W. Sommerfeld/A. Archi/H. Weiss, Why »Dada measured 40,000 liters of barley from Nagar for Sippar«. 4th Internat. Congress of the Arch. of the Ancient Near East Berlin March 29 – April 3, 2004. Poster presentation, ‹http://leilan.yale.edu/sites/default/files/publications/figure-specific/poster2.jpg› (25.08.2015).
Staubwasser/Weiss 2006
M. Staubwasser/H. Weiss, Holocene Climate and Cultural Evolution in Late Prehistoric-Early Historic West Asia. Quaternary Research 66, 2006, 372–387.
Stevens et al. 2001
L. R. Stevens/H. E. Wright Jr./E. Ito, Proposed changes in seasonality of climate during the lateglacial and Holocene at Lake Zeribar, Iran. Holocene 11,6, 2001, 747–755, doi:10.1191/09596830195762.
Stevens et al. 2006
L. R. Stevens/E. Ito/A. Schwalb/H. E. Wright Jr., Timing of atmospheric precipitation in the Zagros Mountains inferred from a multi-proxy record from Lake Mirabad, Iran. Quaternary Research 66,3, 2006, 494–500, doi:10.1016/j.yqres.2006.06.008.
Thompson 2000
L. G. Thompson, Ice core evidence for climate change in the Tropics: implication for our future. Quaternary Scien. Rev. 19,1–5, 2000, 19–35, doi:10.1016/S0277-3791(99)00052-9.
Torrescano-Valle/Islebe 2015
N. Torrescano-Valle/G. A. Islebe, Holocene paleoecology, climate history and human influence in the southwestern Yucatan Peninsula. Rev. Palaeobotany Palynology 217, 2015, 1–8, doi:10.1016/j.revpalbo.2015.03.003.
Triantaphyllou et al. 2014
M. V. Triantaphyllou/A. Gogou/I. Bouloubassi/M. Dimiza/K. Kouli/G. Rousakis/U. Kotthoff/K.-C. Emeis/M. Papanikolaou/M. Athanasiou/C. Parinos/C. Ioakim/V. Lykousis, Evidence for a warm and humid Mid-Holocene episode in the Aegean and northern Levantine Seas (Greece, NE Mediterranean). Regional Environmental Change 14,5, 2014, 1697–1712, doi:10.1007/s10113-013-0495-6.
Turner et al. 2008
R. Turner/N. Roberts/M. D. Jones, Climatic pacing of Mediterranean fire histories from lake sedimentary microcharcoal. Global Planetary Change 63,4, 2008, 317–324, doi:10.1016/j.gloplacha.2008.07.002.
Ülgen et al. 2012
U. B. Ülgen/S. O. Franz/D. Biltekin/M. N. Çagatay/P. A. Roeser/L. Doner/J. Thein, Climatic and environmental evolution of Lake Iznik (NW Turkey) over the last ~4700 years. Quaternary Internat. 274, 2012, 88–101, doi:10.1016/j.quaint.2012.06.016.
Verheyden et al. 2008
S. Verheyden/F. H. Nader/H. J. Cheng/L. Edwards/R. Swennen, Paleoclimate reconstruction in the Levant region from the geochemistry of a Holocene stalagmite from the Jeita Cave, Lebanon. Quaternary Research 70,3, 2008, 368–381, doi:10.1016/j.yqres.2008.05.004.
Visicato 1999
G. Visicato, The Sargonic Archive of Tell El-Suleimah. Journal Cuneiform Stud. 51, 1999, 17–30, doi:10.2307/1359727.
Voûte 1961
C. Voûte, A comparison between some hydrological observations made in the Jurassic and Cenomanian limestone mountains, situated to the west and to the east of the Ghab Graben (U.A.R., Syria). In: Association internationale des sciences hydrologiques/Union géodésique et géophysique internationale (eds.), Eaux souterraines dans les zones arides: colloque d'Athènes, 10–18 septembre 1961 (Groundwater in arid zones: Symposium of Athens, 10–18 september). Publ. Assoc. Internat. Hydrologie Scien. 56–57 (Gentbrugge 1961) 160–166.
Wagner et al. 2009
B. Wagner/A. F. Lotter/N. Nowaczyk/J. M. Reed/A. Schwalb/R. Sulpizio/V. Valsecchi/Martin Wessels/Giovanni Zanchetta, A 40,000-year record of environmental change from ancient Lake Ohrid (Albania and Macedonia). Journal Paleolimnology 41,3, 2009, 407–430, doi:10.1007/s10933-008-9234-2.
Walker et al. 2012
M. J. C. Walker/M. Berkelhammer/S. Björck/L. C. Cwynar/D. A. Fisher/A. J. Long/J. J. Lowe/R. M. Newnham/S. O. Rasmussen/H. Weiss, Formal subdivision of the Holocene Series/Epoch: A discussion paper by a working group of INTIMATE (Integration of ice-core, marine and terrestrial records) and the Subcommission on Quaternary Stratigraphy (International Commission on Stratigraphy). Journal Quaternary Scien. 27,7, 2012, 649–659, doi:10.1002/jqs.2565.
Wang et al. 2008
H. Wang/J. A. Holmes/F. A. Street-Perrott/M. P. Waller/R. A. Perrott, Holocene environmental change in the West African Sahel: sedimentological and mineral-magnetic analyses of lake sediments from Jikariya Lake, northeastern Nigeria. Journal Quaternary Scien. 23,5, 2008, 449–460, doi:10.1002/jqs.1154.
Wang et al. 2008a
Y. Wang/H. Cheng/R. L. Edwards/Y. He/X. Kong/Z. An/J. Wu/M. J. Kelly/C. A. Dykoski/X. Li, The Holocene Asian Monsoon: Links to Solar Changes and North Atlantic Climate. Science 308, 2008, 854–857.
Weiberg/Finné 2013
E. Weiberg/M. Finné, Mind or matter? People-environment interactions and the demise of Early Helladic II society in the northeastern Peloponnese. Am. Journal Arch. 117,1, 2013, 1–31, doi:10.3764/aja.117.1.0001.
Weiss 2000
H. Weiss, Beyond the younger Dryas. Collapse as adaptation to abrupt climate change in ancient West Asia and the Eastern Mediterranean. In: G. Bawden/R. M. Reycraft (eds.), Environmental Disaster and the Archaeology of Human Response. Maxwell Mus. Anthr. Papers 7 (Albuquerque 2000) 75–98.
Weiss 2012
H. Weiss, Quantifying Collapse: The Late Third Millennium Khabur Plains. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 1–24.
Weiss 2014
H. Weiss, The northern Levant during the

Intermediate Bronze Age: altered trajectories. In: M. L. Steiner/A. E. Killebrew (eds.), The Oxford Handbook of the Archaeology of the Levant c. 8000–332 BCE (Oxford 2014) 367–387.
Weiss et al. 1993
H. Weiss/M.-A. Courty/W. Wetterstrom/F. Guichard/L. Senior/R. Meadow/A. Curnow, The Genesis and Collapse of Third Millennium North Mesopotamian Civilization. Science 261,5124, 1993, 995–1004, doi:10.1126/science.261.5124.995.
Weiss et al. 2012
H. Weiss/S. W. Manning/L. Ristvet/L. Mori/M. Besonen/A. McCarthy/P. Quenet/A. Smith/Z. Bahrani, Tell Leilan Akkadian imperialization, collapse and short-lived reoccupation defined by high-resolution radiocarbon dating. In: H. Weiss (ed.), Seven Generations Since the Fall of Akkad. Stud. Chaburensia 3 (Wiesbaden 2012) 163–192.
Welc/Marks 2014
F. Welc/L. Marks, Climate change at the end of the Old Kingdom in Egypt around 4200 BP: New geoarchaeological evidence. Quaternary Internat. 324, 2014, 124–133.
Weninger/Clare 2014
B. Weninger/L. Clare/F. Gerritsen/B. Horejs/R. Krauß/J. Linstädter/R. Özbal/E. J. Rolling, Neolithisation of the Aegean and Southeast Europe during the 6600–6000 calBC period of Rapid Climate Change. Doc. Praehist. 41, 2014, 1–31.
Wick et al. 2003
L. Wick/G. Lemcke/M. Sturm, Evidence of Lateglacial and Holocene climatic change and human impact in eastern Anatolia: high-resolution pollen, charcoal, isotopic and geochemical records from the laminated sediments of Lake Van, Turkey. Holocene 13,5, 2003, 665–675, doi:10.1191/0959683603hl653rp.
Wirth 1971
E. Wirth, Syrien: eine geographische Landeskunde. Wiss. Länderkde. 4–5 (Darmstadt 1971).
Yener 2005
K. A. Yener, Conclusions. In: K. A. Yener (ed.), The Amuq Valley Regional Projects 1. Surveys in the Plain of Antioch and Orontes Delta, Turkey, 1995–2002. Orient. Inst. Publ. 131 (Chicago 2005) 193–202.
Zanchetta et al. 2012
G. Zanchetta/A. Van Welden/I. Baneschi/R. Drysdale/L. Sadori/N. Roberts/M. Giardini/C. Beck/V. Pascucci/R. Sulpizio, Multiproxy record for the last 4500 years from Lake Shkodra (Albania/Montenegro). Journal Quaternary Scien. 27,8, 2012, 780–789, doi:10.1002/jqs.2563.
Zangger et al. 1997
E. Zangger/M. E. Timpson/S. B. Yazvenko/F. Kuhnke/J. Knauss, The Pylos Regional Archaeological Project 2. Landscape Evolution and Site Preservation. Hesperia 66,4, 1997, 549–641.
Zhang/Hebda 2005
Q.-B. Zhang/R. J. Hebda, Abrupt climate change and variability in the past four millennia of the southern Vancouver Island, Canada. Geophysical Research Letters 32,16, 2005, L16708, doi:10.1029/2005GL022913.

Source of figures

1 R. Seager (Columbia University); based on data from the National Centers for Environmental Prediction/National Center for Atmospheric Research Reanalysis at the National Oceanic and Atmospheric Administration
2 author; M. Besonen (Texas Agricultural & Mechanical University)
3 author; S. Maples (Stanford University); data source A. Jarvis/H. I. Reuter/A. Nelson/E. Guevara, 2008, Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org)
4 author; S. Maples (Stanford University); data source FAO 1966; map data © Google, Landsat TOA Percentile Composite, Feb–June 2002
5 M. Arrivabeni (Freie Universität Berlin); L. Ristvet (University of Pennsylvania); E. Rova (Universita Ca'Foscari, Venezia); author
6–9 author
10 author; S. Maples (Stanford University); data source A. Jarvis/H. I. Reuter/A. Nelson/E. Guevara, 2008, Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org)

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Bislang erschienene Bände in der Reihe »Tagungsbände des Landesmuseums für Vorgeschichte Halle«

Die Reihe der Tagungsbände des Landesmuseums wurde 2008 ins Leben gerufen. Anlass dazu war die Konferenz »Luthers Lebenswelten«, die im Jahr 2007 in Halle ausgerichtet wurde. Bereits der zweite Tagungsband widmete sich mit dem Thema »Schlachtfeldarchäologie« dem Mitteldeutschen Archäologentag, der seit 2008 jährlich von Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt veranstaltet und zeitnah publiziert wird. Dem großen Anteil internationaler Autorinnen und Autoren entsprechend, erscheinen viele Beiträge dieser Reihe in englischer Sprache mit deutscher Zusammenfassung.

Mit dem bislang zuletzt erschienenen Tagungsband konnten die Vorträge und Posterpräsentationen des 6. Mitteldeutschen Archäologentags »Metalle der Macht – Frühes Gold und Silber« in zahlreichen Artikeln renommierter Forscher verschiedenster Fachdisziplinen vorgelegt werden.

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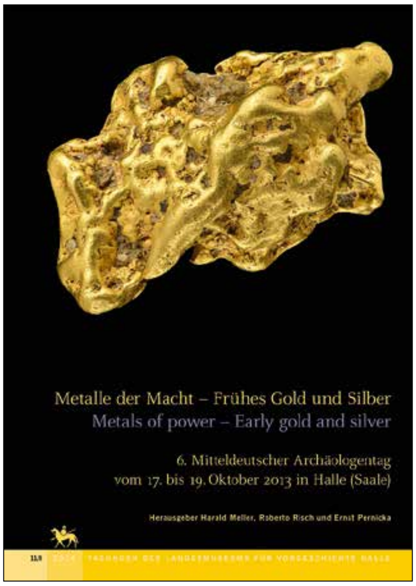

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