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Altered Trajectories: The Intermediate Bronze Age in Syria and Lebanon 2200–1900 BCE

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Introduction

Societies adapted quickly to altered dry-farming cereal production at the onset and terminus of the 4.2–3.9 kaBP (4200–3900 years ago, or 2200–1900 BCE) abrupt climate change. Relatively high-resolution and independent archaeological and paleoclimate records document that the period of abrupt climate change began with: 1) regional abandonments; 2) habitat-tracking to riparian, paludal, and karst spring-fed refugia; and 3) nomadization (subsistence-transfer from agriculture to pastoral nomadism). Adaptive social responses at the termination of the abrupt climate change included: 1) sedentarization; 2) political state formation; 3) increased and enhanced surplus agro-production; and 4) politico-territorial expansion. This 300-year period provides, therefore, an alluring Holocene example of societal responses to abrupt climate change across the eastern Mediterranean and west Asian landscapes, and in particular across steep gradient ecotones of modern Syria and Lebanon. Most of these societal processes have previously been categorized archaeologically and historically as components of the unexplained 'Intermediate Bronze Age', 'Early Bronze–Middle Bronze Transition', 'Akkadian collapse', and 'Amoritization'. The relatively highly resolved data currently available for the 4.2–3.9 ka BP abrupt climate change and the Intermediate Bronze Age of west Asia (2200–1900 BCE) have focused much paleoclimate and archaeological research on the period, even though century-scale Holocene climate changes different in their characteristics (abrupt, high-magnitude) also occurred at 8.2 (Weninger *et al*. 2009, 5.2 (Staubwasser and Weiss 2006), and 3.2 (Kaniewski *et al*. 2010) ka BP.

The paleoclimate record: 4.2–3.9 ka BP abrupt climate change

Moisture-laden North Atlantic cyclonic westerlies seasonally break into the Mediterranean trough and provide the winter precipitation needed for dry

farming along the northern plains and mountain valleys of west Asia, as well as the spring melt that sustains Euphrates flood-plain agriculture in Syria and Tigris-Euphrates irrigation agriculture in southern Iraq (Cullen *et al.* 2002; Lionello *et al.* 2006; Luterbacher *et al.* 2006). The annual variability in this seasonal precipitation during the modern instrumental period diverges from what is now known of changes in the pre-instrumental period, which shows several century-scale disruptions with abrupt onsets and terminations. High-resolution paleoclimate proxy records, including lake, marine, speleothem, and glacial cores with annual resolution, document these century-scale excursions within the relative frequencies of stable isotopes, usually oxygen and carbon, as well as pollen and aeolian dust. The 4.2 ka BP–3.9 ka BP abrupt climate change is now well-recorded globally and, within the limits of chronological resolution, synchronously (e.g., North America: Dean 1997; Zhjang and Hebda 2005, Booth *et al*. 2005, Li *et al.* 2007, Fisher *et al*. 2008, Menounos *et al*. 2008; South America: Thompson 2000, Baker *et al.* 2009, Licciardi *et al*. 2009; West Asia: Staubwasser and Weiss 2006; East Asia: Schettler *et al.* 2005, Wang *et al.* 2005, Liu *et al*. 2010). In the Mediterranean and western Asia, the 4.2 ka BP excursion was a sudden cooling and aridification, the product of a still unexplained weakening of North Atlantic cyclogenesis (Cullen *et al.* 2000; Cullen and deMenocal 2000; Weiss 2000; Bond *et al*. 2001) or deflection of the westerlies. Three hundred years later, westerlies-borne precipitation bounced abruptly back to its pre-aridification event levels.

The multi-proxy stack

The distribution of the proxy climate change variables is illustrated in Figure 1, a multi-proxy stack from the Mediterranean westerlies region and, as well, the glacial core at Kilimanjaro (Thompson *et al.* 2002), indicating the larger-scale regions similarly affected. The Gulf of Oman marine core (Cullen *et al.* 2000) displays a carbonate and dolomite dust spike of 300 years and provides both the radiocarbon and tephrochronological linkage with 2200 BCE Tell Leilan (Weiss *et al.* 1993). The Lake Van core (Lemcke and Sturm 1997) quartz is background dust, understood as a function of aridification beginning at 2190 BCE. The dust does not represent suddenly intensified Mesopotamian agriculture, which would have caused a relatively minor disturbance; more intensive agricultural activity in southern Mesopotamia, such as during the Sassanian dynasty, did not generate similar dust spikes. In fact, similar dust spikes occur at Italian lake cores synchronously with precipitous *natural*

deforestation (di Rita and Magri 2009; Magri and Parra 2002). Noticeably, however, some of the other Van proxies do not show this spike. The Gölhisar Lake core in southwest Turkey (Eastwood *et al.* 1999) provides the same dust spike, and the parallel increases and decreases in $\delta^{18}O$, a proxy for precipitation decreases and increases in these realms (Leng *et al.* 2010; Fairchild *et al.* 2006). Dead Sea levels fell *c.* 45 meters during this same period, then returned to a higher than previous level for the following 600 years, until the Late Bronze Age collapse (Migowski *et al.* 2006; Frumkin 2009; Kaniewski *et al.* 2010). The highest density of data points within a proxy record for this region, *c.* 15-year intervals, is the Red Sea core at Shaban Deep (Arz *et al.* 2006), where the $\delta^{18}O$ spike is constrained to *c.* 250 years. One attempt to transfer proxy values to precipitation values is from Soreq Cave, near Jerusalem, where the $\delta^{18}O$ speleothem spike has been estimated to reflect a *c.* 30 per cent precipitation reduction (Bar-Matthews *et al.* 1997; Enzel *et al.* 2003; Jex *et al.* 2010). The resolution of these Soreq samplings, TIMS Th/U datings of consecutive laminae, is *c.* 100 years. The synchronous Soreq $\delta^{13}C$ spike, also reported at Gölhisar (Leng *et al.* 2010), likely reflects a sharp increase in drought-advantage C4 vegetation (Bar-Matthews and Ayalon 2004: 381). In Italy, the Renella flowstone's Z score (Drysdale *et al.* 2006) records a precipitous aridification event that also appears in several Italian lake records (e.g. Magny *et al.* 2007; Magri and Parra 2002). Lastly, the 'Middle Holocene Dust Event' record from the Kilimanjaro glacial cores (Thompson *et al.* 2002; Davis and Thompson 2006), with annual ice lamination dating, is slightly divergent chronologically, but numerous well-dated east African lake level reductions, the product of synchronous deflection of the Indian Ocean monsoon and Somali jet sources for the Nile, independently conform to the Kilimanjaro and Mediterranean westerlies record (Gasse 2000; Gasse and van Campo 1994). The east African lake level records explain the synchronous diminution of Nile flow coincident with the First Intermediate Period in Egypt (Stanley *et al.* 2003).

The 4.2 ka BP event noted in Anatolian lake pollen cores (Weiss 2000) has been amplified considerably. At Gölhisar the $\delta^{13}C$ spike (Leng *et al.* 2010; Eastwood *et al.* 2007) is synchronous with the carbonate and $\delta^{18}O$ spikes (fig. 1). At Eski Acigöl, mesic trees declined with falling lake levels (Roberts *et al.* 2001). Pollen, benthic foraminifera, and geochemistry confirm these observations at Aegean and Levantine seas (Schmiedl *et al.* 2010; Kotthoff *et al.* 2008), Lake Van, Turkey (Wick, Lemcke, Sturm 2003), Maharlu, central Iran (Djamali *et al.* 2009), and the Caspian Sea (Leroy *et al.* 2007).

Recent research has focused on the components of the aridification event. Tuscan and Albanian lake core pollen and geochemistry suggest brief initial and terminal humid phases (Magny *et al*. 2009), and the mini-spikes of $\delta^{18}O$ at Soreq Cave have been interpreted as short droughts between wetter stretches (Kuzucuoğlu 2007). The latter, however, are not congruent with higher resolution samples, the Soreq $\delta^{13}C$ record, nor the numerous Mediterranean and western hemisphere paleoarchives. Similarly, a time-transgressive quality (Roberts *et al*. 2001) is supported by neither the available chronological resolution nor the regional and global chronologies.

The uniquely resolved multi-proxy analysis of a 10-cm diameter subfossil *Tamarix* stem from a Mt. Sedom (Dead Sea) diapir included three radiocarbon dates with 60-80 year standard deviations, 109 carbon and nitrogen stable isotope measurements from rings dated by interpolation of the calibrated radiocarbon dates' peak probabilities, and transfer of the $\delta^{13}C$ measurements to modern precipitation values. The *Tamarix* stem analyses document three or four successive multi-decadal droughts that reduced regional precipitation by 50 per cent between 2200 and 1900 BCE (Frumkin 2009).

<u>The archaeological record: regional social responses</u> (2200–1900 BCE)

Across Syria and Lebanon are five regions distinguished by their precipitation and hydrological resources: dry-farming plains, semi-arid steppe, rivers, swamps, and karstic springs. These were the stage for the adaptive social responses to the abrupt climate changes: political collapse and regional abandonment, nomadization, and habitat-tracking (Coope 1979; Eldredge 1985: 10; Grosjean, Núñez and Cartajena 2005), followed by resettlement, political consolidation, and state expansion.

<u>The Khabur Plains and the Akkadian Empire</u>

The Akkadian extraction and deployment of cereal revenues from the rain-fed agriculture regions of Mesopotamia extended from Susa through Kirkuk/Nuzi, Erbil/Arbilu, Mosul/Nineveh to the Khabur Plains of northeast Syria dominated by Leilan/Shekhna, Mozan/Urkesh, and Brak/Nagar. At those cities the depth and extent of the Akkadian control is manifest in the monumental public buildings, Akkadian administrative texts, school texts (de

Lillis-Forrest *et al*. 2007), and standardized flat-based s i l a_3-ration bowls (Senior and Weiss 1992). Impressive epigraphic representations include also the name-stamped foundation bricks at Brak's Naram-Sin fortress (Mallowan 1947: 66, pl. LXIV), the sealing of the daughter of Naram-Sin, wife of the ruler, at Mozan/Urkesh (Buccellati and Kelly-Buccellati 2002), and the seal impression of Haya-abum, the Akkadian *šabra*, at Tell Leilan (de Lillis-Forest *et al*. 2004). As in other Akkadian imperialized domains, the target was cereal production revenues to augment the irrigation-agriculture imperial economy in southern Mesopotamia. One imperial Akkadian document, purchased in Baghdad by the British Museum shortly after Rassam's excavations at nearby Sippar, records receipt of 29 metric tons of barley, or 20,000 man-days of rations, from a city Nagar (Sommerfeld *et al*. 2004). These were likely the transported harvest of Akkadian-controlled lands in the high cereal-yield areas around Leilan and Mozan, where a cultivated hectare or two, at 1200 kg/ha (Weiss 1986), produced *c*. 400 man-days of barley rations for Akkadian workers. This combination of high yields and extensive cultivable land could have sustained multiples of the regional Akkadian period population and imperialized cereal revenues, and did so only 300 years later (fig. 2; Ristvet and Weiss 2005).

When precipitation dropped *c*. 30 per cent during the 4.2 ka BP abrupt climate change (Bar-Matthews *et al*. 1997), the Khabur Plains cultivable land areas narrowed (Staubwasser and Weiss 2006: figs. 4–5) and regional cereal yields plummeted. Previously marginal production areas, such as the area around Brak, dropped to the lower limits of cereal dry farming. The Akkadians departed suddenly and with them departed the indigenous regional population. The Tell Leilan Region survey, a thirty-kilometer wide north–south 1800 square kilometer transect through the heart of the eastern Khabur Plains, documents an 82 per cent reduction in settled area for the period immediately after the Leilan Akkadian palace abandonment (Ristvet and Weiss 2005; fig. 2). The elimination of imperial revenues from the Khabur and the other imperialized dry-farming plains truncated imperialized grain flow to the Akkadian capital. Evocative epigrams for the subsequent Akkadian collapse in southern Mesopotamia include 'On its canal-bank tow-paths the grass grew long' (The Curse of Akkade: Black *et al.* 2006: 124) and 'Who was king, who was not king' (Sumerian King List: Glassner 1993: 140), and, in northern Mesopotamia, '…seven generations since the Fall of Akkad' (Shamshi-Adad: Grayson 1987: 53; Glassner 1993: 22), and of Shamshi-Adad's predecessors, 'the seventeen (Amorite) kings who lived in tents' (Assyrian King List: Glassner 1993: 147). The contemporary epigraphic

record for the Akkadian collapse (Glassner 1986) has been amplified and quantified through recent archaeological measurement of regional site abandonments, site-size reductions, and their rates of change on the Khabur Plains, as well as by the new paleoclimate records for abrupt climate change.

The Akkadians built several public structures at the north and south edges of the *c.* 40-hectare Tell Brak/Nagar acropolis. At the southern edge, the massive Naram-Sin fortress was probably intended for regional grain harvest storage, but, a Rimush-inscribed vase fragment notwithstanding, this building was likely still unfinished at the site's desertion: its walls were still under construction, a prepared floor was laid upon only one of four courtyards (Mallowan 1947), and re-excavation shows the walls' foundation trench, but no working/living exterior floor (Oates, *et al.* 2001: fig. 15). The unprovenienced sealing of Talpuš-atili of Nagar may date from shortly after the desertion, but the lack of evidence for a 'Hurrian period' rebuilding of the fortress suggests it to be as evanescent as the Ur III tablets and seal impressions once reported there (Sallaberger 2007: 432). Succeeding the Akkadian collapse and abandonments were a few short-lived houses of the ill-defined Period N in area CH (Oates et al. 2001). Similarly, the ramshackle, post-Akkadian pisé construction on top of the formal mudbrick Akkadian building in area TC was only capped by a c. 1 meter deposit of collapse and dust, not sealed by later occupation, likely an accumulation of centuries (Emberling and McDonald 2003). The Brak occupational hiatus extended to the nineteenth-century Khabur ware period's precipitation bounce-back, when some domestic construction appeared at the western (HH) and northwestern (HN) edges of the acropolis (McDonald and Jackson 2003).

Akkadian-controlled, 90-hectare Tell Leilan/Shekhna was similarly abandoned at *c.* 2200 BCE. 'The Unfinished Building' on the southern side of the Leilan acropolis's Akkadian street was without a finished interior floor, with its walls built to only three or four mudbrick courses above dressed basalt block bases (like ones used at the Mozan Akkadian palace), when the city was deserted (Ristvet and Weiss 2000; de Lillis-Forrest *et al.* 2004). At the glacis-protected Akkadian palace across the street, where grain harvests were collected and processed, clay balls for tablet manufacture an uninscribed clay tablets were left on a palace room floor when the Akkadians walked away from the acropolis (Ristvet and Weiss 2008). Lastly, the walled residential lower town of *c.* 75 hectares was abandoned (Weiss 1990). Four rooms of the more than 17-room palace were subsequently rebuilt (Leilan Period IIc) and are the only post-Akkadian constructions yet detected within the site.

Numerous radiocarbon dates from the Akkadian palace and its post-Akkadian rooms indicate that the remnant re-occupation here and the other, infrequent, post-Akkadian Khabur Plains occupations survived less than three decades after the Akkadian palace abandonment (fig. 2).

At 100-hectare Tell Mozan/Urkesh, close to the Tur Abdin Mountains, the Akkadian period palace of large dressed basalt blocks and mudbrick construction (Buccellati and Kelly-Buccellati 2000) was abandoned at about the same time as the Akkadian collapse at Brak and Leilan. Here, the indigenous population also abandoned the lower town, and the city was reduced to a still smaller acropolis (Pfälzner *et al*. 2004). This was the post-Akkadian period of Atal-shen and Tish-atal of 'Urkesh and Nawar', the latter settlement probably located 30-kilometers northeast at Gir Nawaz (Sallaberger 2007). Some recent studies based on excavation-retrieved archaeobotanical samples and an early paleoclimate model (Bryson 1997) conclude that Mozan environs did not experience an arid climate excursion during this period (Deckers *et al*. 2010). However, archaeobotanical records, whether at Mozan, at Brak (Charles and Bogard 2001), or elsewhere, are not *paleoclimate* proxies; rather, they are the social products of a cultural filter. Meanwhile, the paleoclimate model used in the Mozan study had been rejected a decade ago because the frequency and intensity of the Mediterranean westerlies was unknown (Bryson and Bryson 2000: 80-81).

Elsewhere across the Khabur Plains, the hastened search for and excavation of post-Akkadian settlement has, so far, produced three occupations, two certainly very small, and all abandoned prior to the Khabur ware period resettlement. At 30-hectare Tell Arbid, 45 kilometers south of Tell Mozan, the limited post-Akkadian occupation followed the building traditions and material culture neither of the preceding Akkadian nor the subsequent Khabur-ware period. Rather, two houses and fragments of a street succeeded an abandoned Akkadian building in an area later used as a Khabur-ware period cemetery (Koliński 2008). Radiocarbon dates are not yet available for this excavation and the extent and duration of the Akkadian and post-Akkadian settlements are unknown.

At 12-hectare Chagar Bazar, 22-kilometers south of Mozan, alongside the Wadi Khanzir and the 'old road' from Hasseke to Qamishli, post-Akkadian occupation was located only at the *c.* 5-hectare southern mound: the terminal 'Bâtiment 1', a four-room house, possibly two-story and 'communal'. No radiocarbon dates are available, but the ceramic assemblage

is similar to that of Leilan IIc and Brak N. The earlier Akkadian occupation, yet untested, may have extended across 12 hectares (Tunca *et al*. 2007).

'Late third millennium' occupations, only preliminarily divided into Akkadian and post-Akkadian periods, and without radiocarbon dates, have been surveyed and excavated at 100-hectare Hamoukar still further East. This is the only large Khabur Plains site not adjacent to a seasonal stream. After its early Akkadian building abandonment, except for evidence of a few post-Akkadian pits (Gibson 2001; Gibson *et al.* 2002; Ur 2002), Hamoukar was never reoccupied. Along the Jaghjagh River, at Tell Barri, a sounding has retrieved a post-Akkadian kiln (Pecorella and Pierobon 2004: 21, 29; Orsi 2008). West of the Jaghjagh River, a Tell Beydar temple was still used during at least part of the Akkadian period but was abandoned subsequently (Lebeau and Bretschneider 1997: 158). In general, Khabur Plains post-Akkadian sedentary settlement was reduced greatly, a short-lived step to almost three centuries of desertion similar to the synchronous settlement history of dry-farming Palestine (Gophna 1992). The Akkadian collapse on the Khabur Plains was, therefore, a regional process manifest within the synchronous public building and lower town abandonments at Leilan, Mozan, and Brak, accompanied by the widespread, rural settlement abandonment that is visible in the Leilan Regional Survey. The Khabur Plains were largely empty of sedentary occupations periodically for social and political reasons, even into the early twentieth century (Göyünç and Hutteroth 1997: 62, Abb. 17), but at this time, as at *c*. 3000 BCE (Weiss 2003; Staubwasser and Weiss 2006), century-scale aridification radically reduced dry farming.

The Euphrates River Drainage and the Balikh River

Away and apart from the Akkadian imperialized realms, state polities and region-wide settlements were similarly affected by precipitation reduction and agricultural dislocation. Euphrates flow was probably diminished, but did not cease, during this period. Hence habitat-tracking from dry-farming areas to Euphrates River settlements in Syria and southern Mesopotamia was one response of dry-farming sedentary agriculturalists and, probably, pastoralists as well (Weiss *et al.* 1993; de Boucheman 1934). Urban settlement flourished and expanded along the middle Euphrates during this *shakkanaku* period at Mari and its environs (Geyer and Monchambert 2003; Butterlin 2007: 242), as at Tuttul (Miglus *et al*. 2007) and Emar, greater than 40 hectares (Faist and Finkbeiner 2002: 191).

Settlement along the Balikh River was always limited, as Balikh spring flow from karstic 'Ain al-Arus was less than 6 m^3/sec, within a channel that rarely exceeded six meters across (Wirth 1971). In any case, the settlement data from Hammam et-Turkman (3.7 has) are uncertain, and meager riverine Balikh settlement (11 "large" sites, 18 "minor" sites) still is period-wise obscure (Curvers 1991; Wilkinson 1998).

Just south of the Taurus, settlement system collapse and abandonment occurred within the rain-fed agriculture Karababa basin at and around 43-hectare Titriş Höyük, which was then reduced to three hectares (Algaze *et al.* 1996). The same pattern obtained with abandonments at 56-hectareTilbeşar west of Carchemish within the Sajour River drainage (Kepinski 2007), and 100-hectare Kazane Höyük near Urfa (Creekmore 2010). Further south, along the Euphrates, however, settlement expanded greatly during this period in the Carchemish region, although, of course, a definitive study of that *c.* 40-hectare site can only be anticipated (Peltenburg 2007)). Tell es-Sweyhat, a 45-hectare settlement located, curiously, four kilometers east of the Euphrates, at the 200–300-mm limit of dry farming, was occupied extensively to *c.* 2150 BCE in Period 4, and then abandoned thereafter in Period 5, with Period 6 poorly preserved building levels extending only to the early transition to the Middle Bronze Age (Danti and Zettler 2007: 176). The Euphrates drainage region, therefore, indicates continued and thriving occupation during this period along the river, probably the target of habitat-tracking, and pronounced abandonment in the drainage's dry-farming zones. Similar habitat-tracking should have targeted the adjacent Anatolian plateau, within the Tur Abdin/Diyarbakr region of higher precipitation (Weiss and Courty 1993: 144), as has been suggested in the Upper Tigris/Batman region (Laneri *et al.* 2008).

Dry-farming Western Syria and the Steppe

The wealth and power of Ebla on the Idlib Plains made it the famous target of the Mari coalition that destroyed its palace in *c.* 2300 BC (Archi and Biga 2003). Following a short occupational hiatus, the succeeding EB IVB city of this time period was reduced in size while being ruled from the Archaic Palace with its unique water cisterns. The palace construction, however, remained unfinished, like the buildings at Leilan and Brak, probably, and the city was destroyed again in *c.* 2000 BCE (Matthiae 1995a–b; Fiorentino *et al.* 2008).

Around this time, habitat-tracking to the Madekh Swamp, terminus of the Qoueiq River, resulted in the settlement at Tell Touqan (Baffi Guardata 1990).

Further east, at the limits of dry-farming cultivation prior to 2200 BC, the eastern Jabbul Plain, with the 20-hectare town at Umm el-Marra, was abandoned during the aridification period (Nichols 2004). To the south, Rawda, in the semi-arid marginal zone, was also abandoned after *c.* 400 years of occupation. There the radial planned town (Castel and Peltenburg 2007), a major unexplained phenomenon from the Khabur Plains to the Orontes River, was the settlement outpost facing, or replaced by, the Trés Long Mur during the aridification excursion.

The Très Long Mur (fig. 3) was constructed of rough, calcareous and basalt boulders along a 220-kilometer distance following precisely the precipitation isohyets of the western steppe (Geyer *et al.* forthcoming). This western analog to the contemporary 'Repeller-of-the-Amorites' wall in southern Mesopotamia delimited and protected urban agricultural territory from expanding Amorite, steppe nomad, populations—described famously as the people 'who know not agriculture' in 'The Curse of Akkade'. The extended pastoralist cemeteries of this period at the Jebel Bishri, probably mirroring tribal units in the spatial distribution of stone-lined and cairn-marked inhumations, is now under intensive survey and excavation (Ohnuma 2010).

The regional expansion of pastoralism is nowhere better seen than at the edge of the steppe, "The Black Desert," at Khirbert al-Umbashi (Braemer *et al*. 2004), some 70 kilometers southeast of Damascus, where settlement grew from 6 to 60 hectares during this period and comprised *c.* 250 large stone houses. Subsistence here was non-agricultural, exclusively dependent upon sheep-goat herding and dairy production, with no evidence for hierarchical organization. This settlement type, uniquely well-recovered here, extended across the Syro-Palestinian marginal steppe, but was mostly abandoned at *c.* 3.9 ka BP with the sudden return of pre-abrupt climate change precipitation levels.

Orontes River

The Orontes River provides a unique environmental contrast with the Jabbul and Idlib plains. The karstic ‘Ain ez- Zarka, its source, drains a slow infiltration system with 10 billion cubic meters of phreatic zone storage and a mean residence currently around 40 years (Bakalowicz *et al*. 2008; fig. 4) that is extended downstream by other springs. Hence, during this 300-year period of reduced precipitation, the Orontes River attracted and sustained large, habitat-tracking, sedentary agricultural populations (al-Maqdissi 2010). The karstic springs of the Jebel Ansariyeh, Lebanon/Anti-Lebanon, Orontes system include three at 100-hectare Mishrifé/Qatna that were dammed to create a greater than 70-hectare lake during the city’s late third millennium growth (Cremaschi 2007; Morandi Bonacossi 2009; fig. 5). Survey and excavation along the Orontes River have also documented the sudden synchronous growth of square-walled, Qatna-like, 76-hectare Nasriyah, the smaller, but similarly square-walled, Tell She’irat (al-Maqdissi 2010), and the first occupations at 70-hectare Acharné (Fortin 2007), probably ancient Tunip, where 175 karst springs debouche into the paludal Ghab depression (Voûte 1961).

The ‘Amuq Plain, at the terminus of Orontes River karst aquifer flow, provided the cultivable landscape for urban settlement at Ta‘yinat and Atchana probably beginning at this period (Yener 2005: 173). On the western side of the Jebel Ansariyeh, along the fertile littoral, karstic springs provided for the villages of the Akkar Plain and the town at Tell Arqa, where settlement and paleobotanical remains indicating bountiful agriculture are robustly radiocarbon-dated to this period (Thalmann 2006). Coastal Syria and Lebanon lack karstic springs apart from Jeita Cave, along the Nahr el-Kalb Valley near Beirut (Verheyden *et al.* 2008). Hence population reductions and site abandonments were experienced at 23-hectare Ras Shamra/Ugarit between Levels III and II (Yon 1997: 16), at similarly sized Byblos (Saghieh 1983) down the coast, and at Sianu (al-Maqdissi 2006), while occupation continued in some areas of twelve-hectare Tweini at the seaside conjunction of two rivers (Bretschneider and Van Lerberghe 2008).

3.9 ka BP

The abrupt return of pre-4.2 ka BP annual precipitation returned dry farming to the Khabur Plains on the east and to the fertile *terra rossa* plains of Aleppo and Idlib on the west. The resettlement of formerly arid and

abandoned territories was the second stage of Amoritization, the sedentarization of the Amorite pastoral nomads, dramatically recorded in their archaeologically retrieved settlements within the Leilan Region Survey (fig. 2), well-recorded epigraphically and, thereafter, famously engaged in military struggles for control of newly opened lands and agricultural wealth during the nineteenth and eighteenth centuries BC, which initiate the succeeding Middle Bronze Age. While the physical return of dry-farming lands is now clear, the social forces behind this resettlement remain to be explored.

Conclusions

Archaeological perspectives on late-third millennium Syria and Lebanon often view them as featureless isotropic planes, separate from the available and rich environmental and paleoclimatic data, and thereby provide a settlement and abandonment profile that is at once reductionist and stochastic (e.g. Marro and Kuzucuoğlu 2007; Schwartz 2007). The patterning of social responses to the late third millennium abrupt climate excursion across hydrologically varied plains stands in marked contrast to the apparent randomness within only two-dimensional views. Interpretations that champion the conscious self-determinism of these ancient societies evaporate alongside the illusory randomness. The non-imperialized settlements in dry-farming terrains collapsed unless situated, like Iktanu (Prag 2007), adjacent to karst springs. The Akkadian empire, barely a generation old, was expanding when it collapsed suddenly: 1) The "Seventeen Kings against Naram-Sin" had been defeated (Westenholz 1997); 2) monumental imperial Akkadian architecture was in the course of construction at Leilan and Brak; 3) the marriage of Naram-Sin's daughter had successfully sealed the Akkadian alliance at Mozan.

The steppic, riparian, paludal, and karstic resources of Syria and Lebanon were the adaptively utilized theater for the dramatic social and environmental interactions, and the altered trajectories, at the 4.2–3.9 ka BP abrupt climate change. Societies responded to the abrupt climate change with political collapse, regional abandonment, nomadization, and habitat-tracking to sustainable agricultural regions. These adaptations provided demographic and social resilience across the West Asian landscape.

The accessibility of testable, reproducible, paleoclimate proxies extends collapse research horizons beyond the concatenation of imagined events to the quantification of transfer functions and rates of climate change that are now well-documented globally. Similarly, quantification of the dynamics and variability within adaptive regional habitat-tracking, nomadization and sedentarization are new archaeological challenges for this and other prehistoric and early historic abrupt climate change research.

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<u>Figures</u>

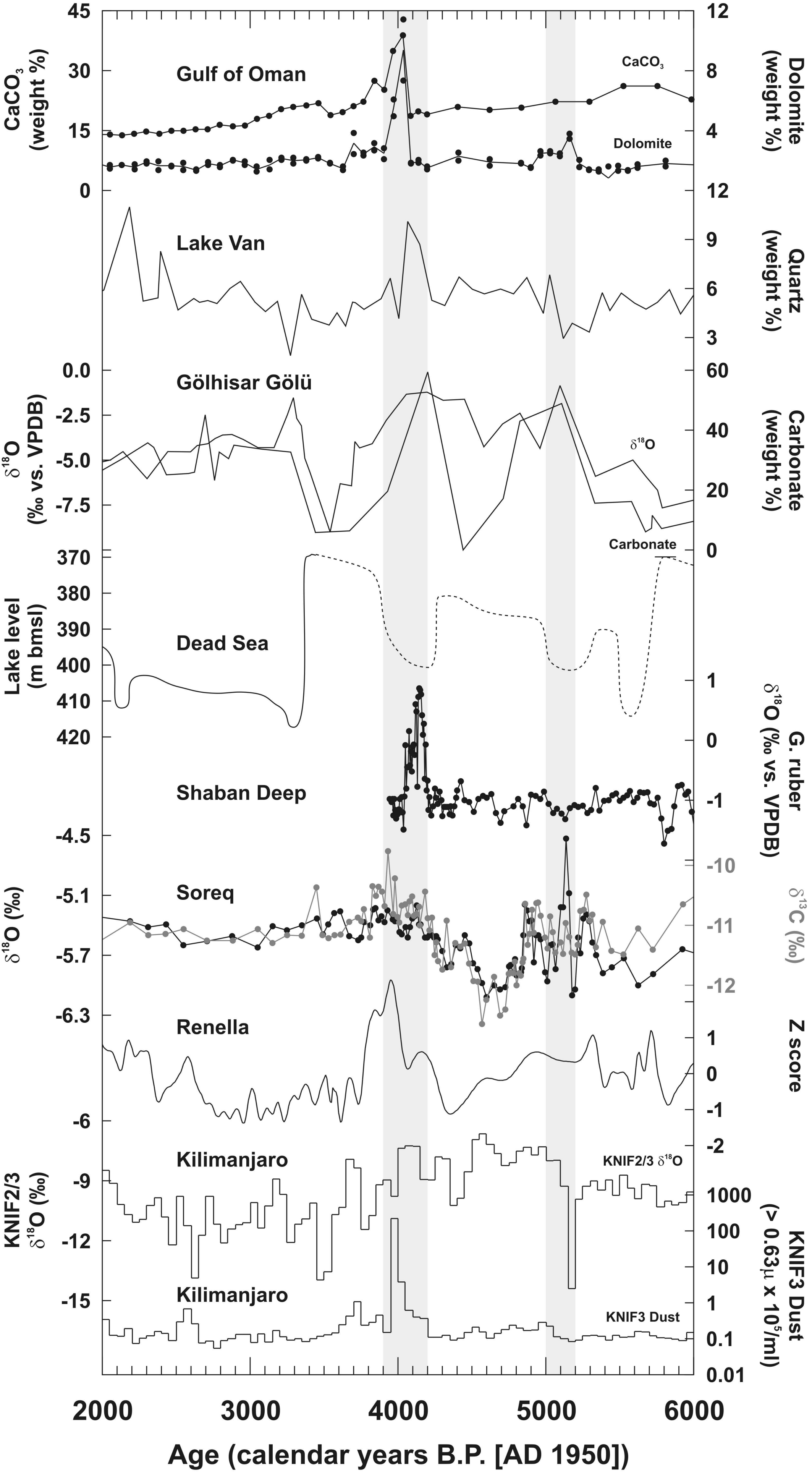
1. **Multi-proxy stack Mediterranean westerlies and Kilimanjaro, displaying the 5.2 and 4.2 ka BP abrupt climate change events within marine, lake, speleothem, and glacial records (H. Weiss and M. Besonen).**

2. **Leilan Region Survey histogram: preliminary analysis of settled areas showing sedentary population reductions during 5.2 and 4.2 ka BP abrupt climate change events. Minor 'post-Akkadian settlement' persisted for a few decades after initiation of the 4.2 ka BP abrupt climate change (H. Weiss, L. Ristvet, and J. Kosslyn).**

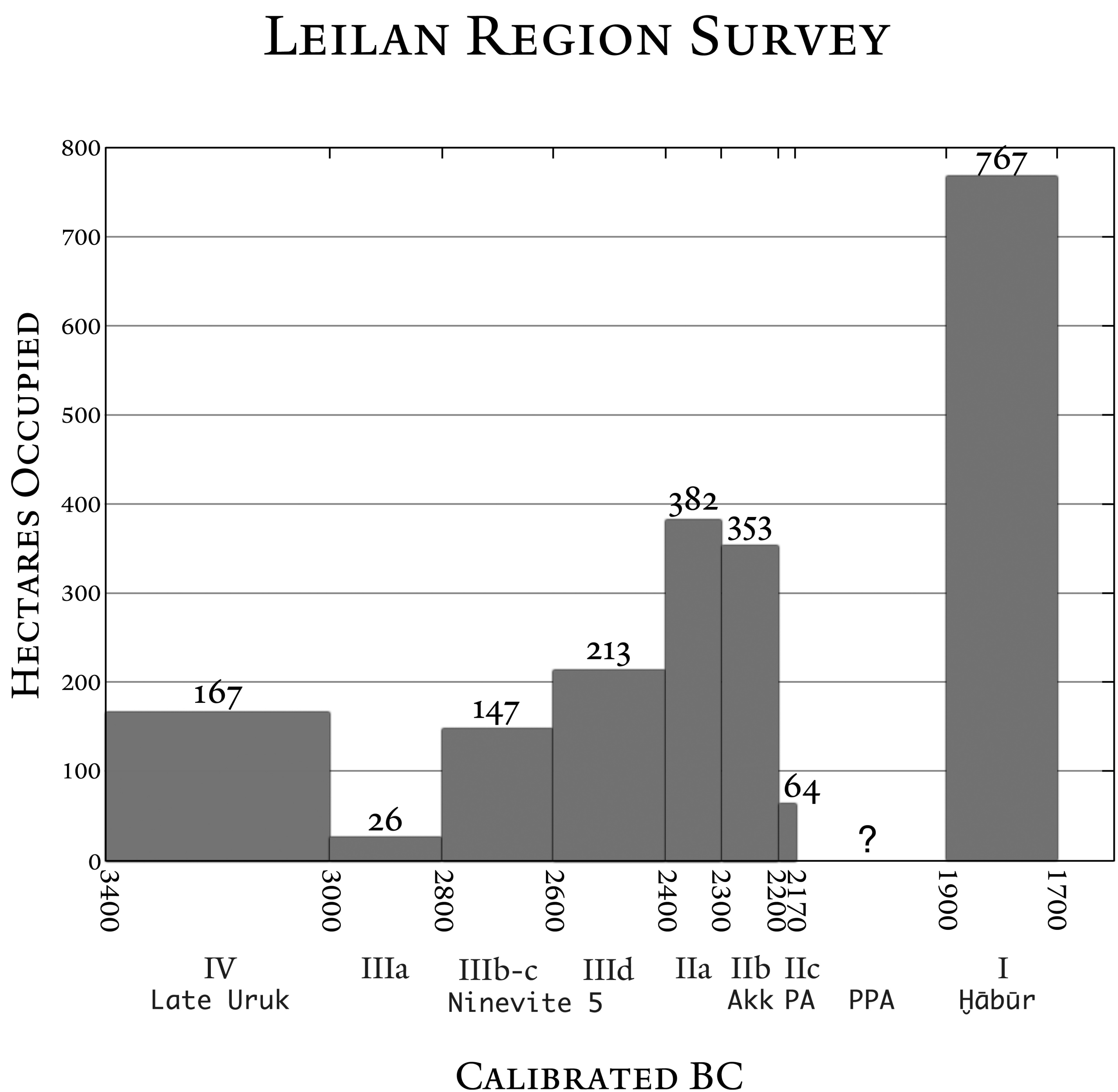
3. **Syria and Mesopotamia, 4.2–3.9 ka BP. Dry-farming settlement diminished while riparian, paludal, and karstic refugia expanded. The Très Long Mur was constructed and the Jebel Bishri became the pastoralists' regional cemetery (H. Weiss and S. Maples).**

4. **Ain ez-Zarka, Lebanon, where numerous perennial karstic springs are the source of the Orontes River. Image horizontal is *c.* 4 meters. (Photo: H. Weiss and S. al-Kuntar).**

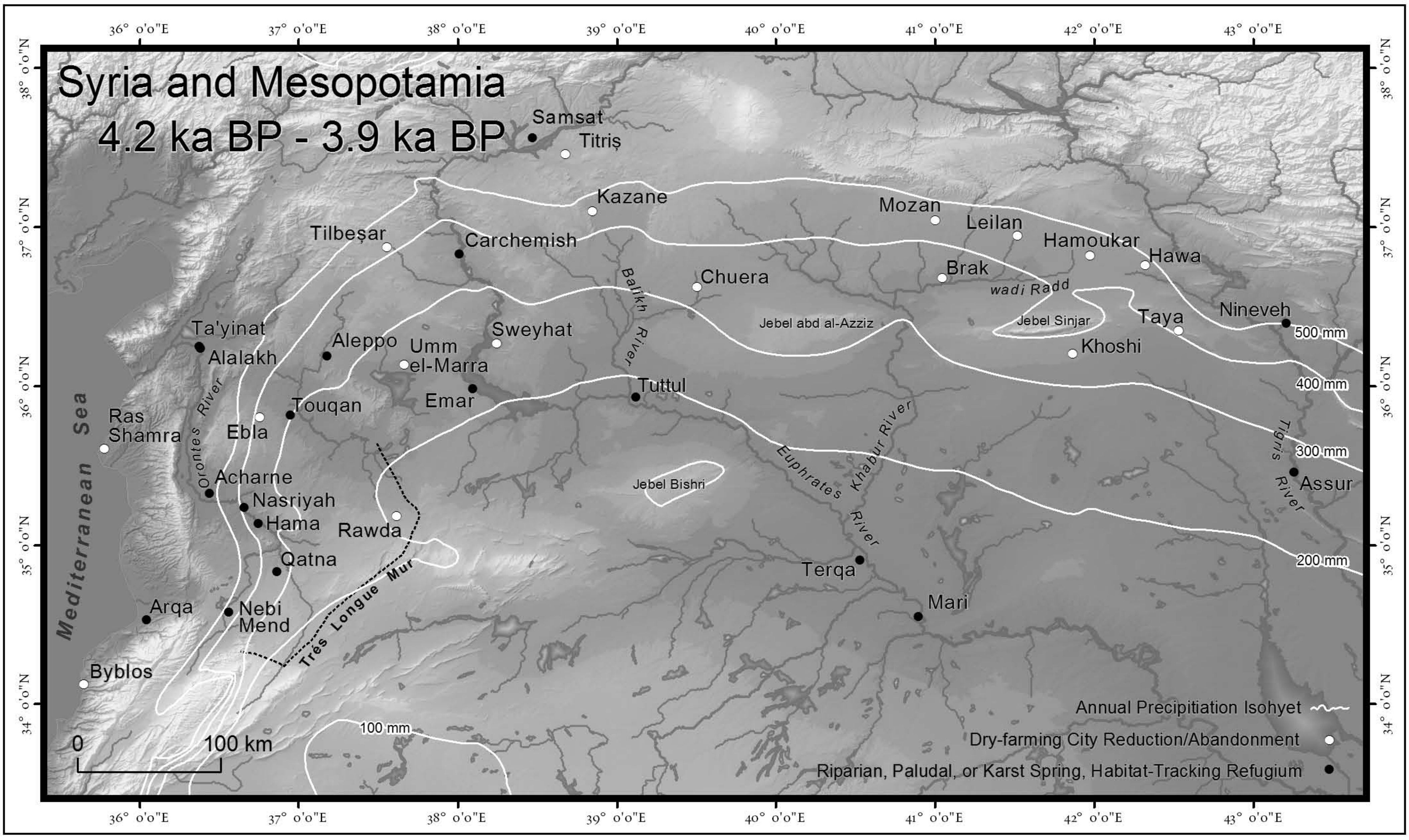
5. **A reconstruction of the settlement at Qatna where M. Cremaschi's cores and analyses identified dammed karst spring flow that produced a reservoir of more than 70 hectares for the settlement's expanding population at *c.* 2200 B.C. (courtesy of D. Morandi Bonacossi).**



Gulf of Oman
CaCO3
Dolomite
CaCO3 (weight %)
Dolomite (weight %)
Lake Van
Quartz (weight %)
Gölhisar Gölü
δ18O (‰ vs. VPDB)
Carbonate (weight %)
δ18O
Carbonate
Dead Sea
Lake level (m bmsl)
Shaban Deep
G. ruber δ18O (‰ vs. VPDB)
Soreq
δ18O (‰)
δ13C (‰)
Renella
Z score
Kilimanjaro
KNIF2/3 δ18O
KNIF2/3 δ18O (‰)
Kilimanjaro
KNIF3 Dust
KNIF3 Dust (> 0.63µ x 10^5/ml)
Age (calendar years B.P. [AD 1950])



LEILAN REGION SURVEY
HECTARES OCCUPIED
800
700
600
500
400
300
200
100
0
167
26
147
213
382
353
64
?
767
3400
3000
2800
2600
2400
2300
2200
2170
1900
1700
IV
Late Uruk
IIIa
IIIb-c
Ninevite 5
IIId
IIa
IIb
Akk
IIc
PA
PPA
I
Ḫābūr
CALIBRATED BC



Syria and Mesopotamia
4.2 ka BP - 3.9 ka BP
Samsat
Titriş
Kazane
Mozan
Leilan
Hamoukar
Hawa
Tilbeşar
Carchemish
Brak
Chuera
wadi Radd
Balikh River
Jebel abd al-Azziz
Jebel Sinjar
Taya
Nineveh
500 mm
Ta'yinat
Alalakh
Aleppo
Umm el-Marra
Sweyhat
Khoshi
400 mm
Emar
Tuttul
Touqan
Ebla
Ras Shamra
Mediterranean Sea
Orontes River
Khabur River
Euphrates River
Tigris River
300 mm
Jebel Bishri
Acharne
Nasriyah
Hama
Rawda
Assur
Qatna
Terqa
200 mm
Très Longue Mur
Arqa
Nebi Mend
Mari
Byblos
100 mm
0
100 km
Annual Precipitiation Isohyet
Dry-farming City Reduction/Abandonment
Riparian, Paludal, or Karst Spring, Habitat-Tracking Refugium
36° 0'0"E
37° 0'0"E
38° 0'0"E
39° 0'0"E
40° 0'0"E
41° 0'0"E
42° 0'0"E
43° 0'0"E
34° 0'0"N
35° 0'0"N
36° 0'0"N
37° 0'0"N
38° 0'0"N