Historical Evidence for Climate Instability and Environmental Catastrophes in Northern Syria and the Jazira: The Chronicle of Michael the Syrian

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ABSTRACT

Significant cataclysms occurred frequently throughout the history of northern Syria and the Jazira, and had severe short- and long-term implications on the region's economy and the social structure. This paper uses the Chronicle of Michael the Syrian, a Patriarch of Antioch in the late twelfth century A.D., as a representation of environmental and climatic catastrophes taking place in northern Syria and the Jazira in the third and early second Millennium B.C. The proportions, general frequency and the clustering tendency of the different disasters in the Chronicle are treated in detail, as well as their general economic, environmental and social significance. The article argues that diversified subsistence and a high degree of flexibility were essential for ancient Mesopotamian societies to absorb the many risks that life in this marginal semiarid environment involved.

KEYWORDS

Jazira, northern Syria, climate, environment, disaster

INTRODUCTION

In models of ancient societies, climate, and especially abrupt climate changes, are often considered, perhaps even reconstructed, in order to explain cultural change or unfamiliar and new settlement patterns. The climate of northern Syria and the Jazira in the Bronze Age (or, more specifically, during the end of the third and the early second millennium B.C.) has recently been a subject of rather intense debate. Most notably, Harvey Weiss and Marie-Agnes Courty have ar-

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gued in a series of articles for an abrupt climate change, drastic arid conditions, sociopolitical collapse and site and regional abandonment. These anomalous conditions of extreme aridification and cooling remained for 300 years until ca. 1900 B.C. when the climate returned to normal, which according to Weiss and Courty roughly corresponded to the present. Others have noted that in the mid-to-late Holocene, small-scale climate changes were rather frequent, and that some of these changes lasted for up to 300 years. In fact, the critique that the above described scenario has received has not been primarily concerned with the notion that the end of the third millennium may have experienced a climate change – a fact that seems to find support in several independent scientific studies – but rather how, if at all, this change would affect the people living in northern Syria and the Jazira. Climatic change *may* have played a role in the alleged urban and demographic collapse, but climate changes or other environmental anomalies should not be isolated from their economic, historic, and structural contexts. Moreover, groups of people may respond to climate change in many different ways and it is necessary to consider environmental disasters more broadly, not just climate change.[1]

While modern science often can reconstruct climate changes over large regions, albeit seldom in great detail or without a significant level of interpretation/adaptation, it remains very difficult to determine the direct significance of these changes to the populations of specific areas. Palaeo-climatic studies of soil micromorphology, isotope composition of lake, marine and ice cores, or solar

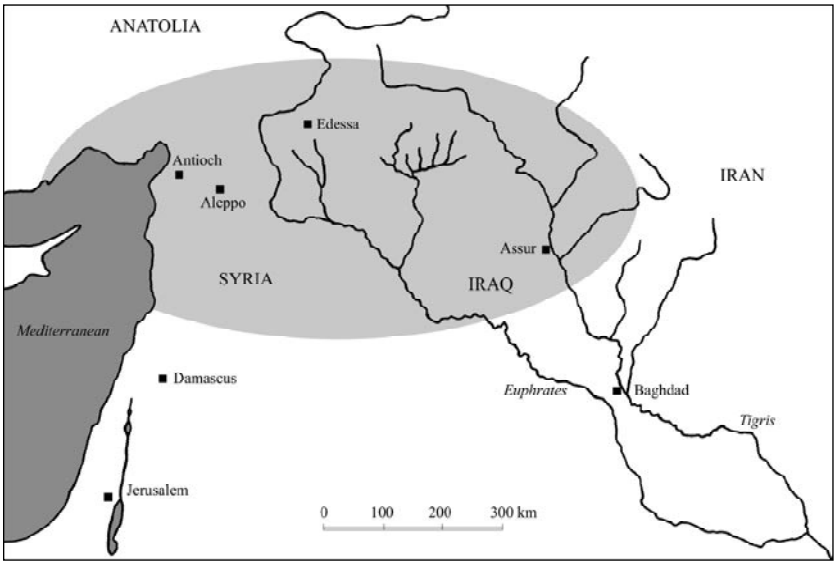


FIGURE 1. Northern Syria and the Jazira

variability of the third millennium are often unable to provide the details and/or the high temporal and geographical resolution provided by textual sources, and such studies are therefore often less suitable to reconstruct natural and climatic idiosyncrasies on a human scale. On the other hand, there can be no doubt that climatic data with a higher temporal resolution are necessary for studies on the social and economic history of the highly sensitive semiarid environment of northern Syria and the Jazira. Gil Stein has recently pointed out that although the *average* annual rainfall in northern Mesopotamia and Syria may suffice for cereal agriculture, 30-year records of modern (that is between roughly 1940 and 1970) rainfall in the region show 'an extremely high rate of interannual variability, often ranging from 30 to 35 per cent'.[2]

Climate is in constant change and there can be no doubt that the climate and environment of every period of history should be considered unique. Nevertheless, it should also be stated that regardless of how we choose to view and label the indisputable climatic variations of the history of Syria and the Jazira, by far the greatest changes on the climate, agricultural production, erosion and land degradation of this region are certainly anthropogenic and have occurred in modern times. The main reasons for these drastic modern changes can be found in the significant increase of atmospheric CO_2 levels, the introduction of chemicals and mechanised deep ploughing in the agricultural production, the introduction of new crops, larger farms and a shift to mono-agriculture, severe overgrazing, excessive pumping of ground water and large-scale dam constructions in Syria and Turkey. While it certainly remains problematic to determine exactly how, and to what extent, these factors together have influenced the modern climate and environment of the region, there can be little doubt that modern climate and environmental data simply applied to ancient societies in this region should be regarded with caution. Thus, while we acknowledge that conditions constantly change and that the climate and environment in the third millennium B.C. certainly was not the same as in the first millennium A.D., it seems reasonable to assume that any pre-industrial differences were, at least by comparison, relatively small.[3]

The most comprehensive pre-industrial account on the climate and environment of northern Syria and the Jazira is provided to us in a mediaeval manuscript usually referred to as the *Chronicle of Michael the Syrian*. The dry farming region in northern Syria and the Jazira described by Michael relied on wheat and barley as the main crops while cash crops included olives and grapes. This does not appear to be different from the general picture archaeologists have depicted of dry-farming agriculture in this region in antiquity. Recent anthracological data from the site of Emar show that both olives and grapes were cultivated (or growing wild) in northern Syria at the end of the third millennium B.C. Moreover, cuneiform texts dated to around 2400 B.C. from Tell Beydar, situated on the minor north-south Wadi Awaidj in the western Habur, show that barley and wheat as well as grapes were cultivated in the region. Furthermore, contemporary

records from Ebla, situated on the fertile plain of north-western Syria about 53 kilometres southwest of Aleppo, contain references to thousands of olive trees growing in northern Syria. In view of these similarities, it seems reasonable to consider the climatic and agricultural data provided by the Chronicle of Michael the Syrian suitable for more general reconstructions of the climate, environment and agricultural disasters of northern Syria and the Jazira in the late third and early second millennium B.C., as well as in antiquity in general.[4]

To provide a more transparent overview of the events described by Michael, this article attempts to summarise and analyse the disastrous elements of Michael's history of the region. The focus in the article is on extreme, usually irremediable, natural calamities on a communal or regional level that severely disrupt the normal routine of life and cause significant loss of property, life or livelihood. A few remarks are made also on the proportion/frequency of the different climatic and natural disasters described as well as their economic, environmental and social significance. When a known specific catastrophe is not recorded in Michael's Chronicle for uncertain reasons, the analysis has been supplemented with data from the *Chronicle of Zuqnin* and other sources. Finally, the author of the present article is focusing mainly on the ancient history of Syria and Mesopotamia, and it should be stated that this work is significantly indebted to Michael G. Morony's excellent, and much more profound, study on Michael the Syrian and his Chronicle.[5]

THE CHRONICLE OF MICHAEL THE SYRIAN

The Orthodox Patriarch Michael the Syrian's monumental Chronicle, encompassing 21 books, represents the most voluminous historical compilation transmitted to us in Syriac. The comprehensive account of Michael the Syrian, who was elected Patriarch of Antioch 1166–1199, provides valuable information concerning abnormal conditions and various climatic and agricultural catastrophes taking place in northern Syria and the Jazira from the sixth century A.D. until the death of Saladin in A.D. 1196.[6]

Unfortunately, we do not know all of the sources that Michael used to compile his Chronicle. From the *Chronicle of Zuqnin* it becomes evident that there are several gaps in Michael's information concerning the storms, droughts and other severe conditions adversely impacting agricultural production in the region. A lack of references to agricultural disasters in Michael's account does not necessarily mean that nothing happened in a particular year. On the other hand, the *Chronicle of Zuqnin* sometimes fails to record severe weather or natural calamities that are found in Michael's history. As already stated by Morony, both Michael and the author of the *Chronicle of Zuqnin* based their earliest accounts on the sixth-century Syriac writer John of Ephesus. Michael also used the *Chronicle of Dionysius of Tell Mahre*, whose history started in 582. As can be seen in Table 1,

TABLE 1. Summary of disasters in northern Syria and the Jazira in the sixth century A.D.

Year	**Disaster**	**Claimed Results**	**Sources**[8]
Spring 500	Locusts	Famine	*Zuqnin; Josue*
528/29	Severe winter		*Zuqnin*
543–44	Plague	Wheat fields went unharvested; Livestock dying	*Zuqnin*
546–54	Crop failure; Flood 549/50	Eight year famine; Flood ruined the vine	*Zuqnin*
Spring 583	Locusts	Lack of bread	*Michael*

Michael seems to have missed most of what happened in the sixth century, and his record from this century cannot be considered reliable.[7]

The agricultural and climatic disasters or catastrophes reported by Michael from 600 to 1196 are more interesting (see Appendices 1 and 2). During the initial 176 years from 600 to 775, which Michael reconstructed using the *Chronicle of Zuqnin* and the *Chronicle of Dionysius*, Michael recorded 41 different catastrophes occurring in 33 different years. Statistically, that would mean that tragedy would strike every 5.3 years, or that there was an 18.8 per cent risk for one or several disasters in any given year.

For the following 68 years from 776 to 843, Michael relied on the final part of the *Chronicle of Dionysius*. Ten of these 68 years (14.7 per cent) are reported to have been afflicted with catastrophes. Michael reported 13 separate disasters for these ten disastrous years: Locusts (8 different years), Hail (2 different years), Storm wind (1 year), Snow (1 year), Freeze (1 year). Unfortunately, the ecclesiastical history of the ninth-century Patriarch Dionysius is lost and the only reason that we know that Michael relied on it is because he is quoting some passages of it in his own work. Thus, we cannot deduce the extent of Michael's reliance on the *Chronicle of Dionysius* or how true he was to it, nor can we say much about the historical and narrative reliability of Dionysius' work. The overrepresentation of locusts and the unexpected absence of severe winters and droughts (see below) suggests that Michael's report of this period does not offer a representative picture of the actual situation, and calls for further caution as for using this data in statistical analyses. After the end of the *Chronicle of Dionysius* in 843, there is a severe gap in Michael's information lasting until the twelfth century. Michael's apparent lack of reliable sources for more than three centuries, from 775 to the end of the eleventh century, makes this entire period less suitable for statistical studies.

For the events of the last 100 years of his Chronicle, from 1097 to 1196, we have to assume that Michael had sufficient access to firsthand sources who personally witnessed or experienced the various events (in addition, of course, to Michael's own experiences and notes during his own lifetime. Michael died

in 1199, three years after the end of his Chronicle). For these 100 years, Michael reported 27 disasters occurring in 20 different years. The statistical 20 per cent risk of having one or several catastrophes in any given year during this period corresponds well with the 18.8 per cent risk in the period from 600 to 775 (see above). Moreover, a detailed comparison of the different catastrophes attested in the two periods displays very similar proportions (see Table 2).

TABLE 2. Disasters in northern Syria and the Jazira in the periods A.D. 600–775 and A.D. 1097–1196

Catastrophe	600–775 (176 years)		1097–1196 (100 years)		Total (276 years)	
	Attestations	Yearly risk	Attestations	Yearly risk	Attestations	Yearly risk
Severe winter	9	5.1%	7	7.0%	16	5.8%
Locusts	10	5.7%	5	5.0%	15	5.4%
Drought	6	3.4%	7	7.0%	13	4.7%
Snow	2	1.1%	3	3.0%	5	1.8%
Storm wind	4	2.3%	1	1.0%	5	1.8%
Freeze	2	1.1%	1	1.0%	3	1.1%
Hail	2	1.1%	1	1.0%	3	1.1%
Flood	2	1.1%	–	–	2	0.7%
Plague	1	0.6%	1	1.0%	2	0.7%
Mildew	1	0.6%	–	–	1	0.4%
Rain	–	–	1	1.0%	1	0.4%
Rats	1	0.6%	–	–	1	0.4%
Weevils	1	0.6%	–	–	1	0.4%
Catastrophes:	41	23.3%	27	27.0%	68	24.6%
Affected years:	33	18.8%	20	20.0%	53	19.2%

DISTRIBUTION, EFFECTS, SEVERITY, AND NATURE OF THE CATASTROPHES

Unfortunately, the Chronicle of Michael is rather laconic in its information concerning the actual results of its enumerated catastrophes and it remains difficult to reconstruct the concrete impact and severity of the different events. Moreover, due to the somewhat sensational character of the Chronicle of Michael, we have to allow for exaggeration in both the extent of the development and the consequences of the events described. In addition, some events were no doubt more local, such as the chicken plague in 1141 or the hail breaking trees and grapevines in the region of Militene in the same year, and did not have widespread effects. Other disasters, however, such as the frequent plagues of locusts

(see below), could be devastating to huge areas. As far as catastrophes related to climate are concerned, it should be noted that more recent climate records from the twentieth century display very high levels of correlation between the climatic events of Syria and northern Mesopotamia. It is therefore likely that such catastrophes affected relatively large areas.[9]

It is important to point out that the table above only offers a simplified representation of the probabilities of catastrophes in northern Syria and the Jazira. The occurrences of climatic and environmental events should not be understood as a stochastic process defined by random variables. The table shows, for example, that there is an average 5.8 per cent probability that any given year within a period of 276 years is going to have a severe winter. However, the underlying mechanisms for every severe winter can be connected to a number of factors, including the climatic and environmental events of previous year(s). The probability for a certain catastrophic event may increase (or decrease) depending on immediately preceding events. For example, the probability for a widespread outbreak of an epidemic of any disease is affected by the population's resistance to human disease, which may be significantly decreased due to nutritional deficiencies. Thus, all outbreaks of epidemics are more likely to occur together with other disasters and general famine. Depending on the particular nature of the disease, some disasters, such as large areas of flooded land, could further exacerbate the outbreak, while other disasters, such as extreme cold, actually could lessen the probability of a major outbreak. Similarly, the catastrophic gregarisation of the locust from its largely harmless solitary phase is not a random event but is determined by an extremely complex and only partly understood array of external climatic and environmental factors. By performing a large number of random simulations using Michael the Syrian's 68 disasters over 267 years, we are able to estimate the expected distribution of disasters if the events were completely random occurrences (see Table 3 and Figure 2). The upper part of the table (A) and the figure show that compared to a random distribution, the risks of having several different disasters occurring in the same year are much higher in Michael's Chronicle. Moreover, there is a clear tendency for Michael the Syrian's disasters to cluster and occur in consecutive years. The lower part of the table (B) shows that while single year events dominate in the random distribution (61.0 per cent of all affected years), only 39.6 per cent of the years affected with one or more disasters in Michael's Chronicle were single-year events. Moreover, Michael the Syrian reports five separate sequences with three consecutive disastrous years and one consecutive period of five years with disasters. The statistical probability for this level of clustering with a distribution of five (or more) separate periods with three consecutive disastrous years and one (or more) period with five consecutive years is only 0.0009 (that is, this distribution occurred 9 times out of the 10,000 performed simulations).

The sequential and accumulative nature of many climatic and environmental disasters is extremely important. In his study of long-term macro-climatic change

TABLE 3. The 68 disasters from Table 2 distributed over 276 years independently using 10,000 simulations (two identical disasters cannot occur in the same year) and according to the Chronicle of Michael the Syrian

# of affected years	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
# from 10,000 simulations	1	3	13	49	137	281	555	960	1,408	1,708	1,823	1,454	930	485	159	29	5
Probability	0.0001	0.0003	0.0013	0.0049	0.0137	0.0281	0.0555	0.0960	0.1408	0.1708	0.1823	0.1454	0.0930	0.0485	0.0159	0.0029	0.0005
Michael the Syrian		M						83% of the simulations									

A. Distribution of the number of affected years with one or several disasters (out of 10,000 simulations) using Michael the Syrian's 68 disasters. The probability for Michael the Syrian's distribution with 53 affected years is 0.0003. Roughly 83% of the simulations are in the range 59–64 affected years.

Sequences of years with disasters	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	Total # of affected years
Average # sequential years from 10,000 simulations	37.4102	16.4570	5.3676	1.5492	0.4085	0.0960	0.0238	0.0104	0.0018	61.3245
% of the total # of affected years	61.0%	26.8%	8.8%	2.5%	0.7%	0.2%	0.0%	0.0%	0.0%	100.0%
Sequential years in Michael the Syrian	21	12	15	0	5	0	0	0	0	53
% of the total # of affected years	39.6%	22.6%	28.3%	0.0%	9.4%	0.0%	0.0%	0.0%	0.0%	100.0%

B. Average number of consecutively affected years in 10,000 independent simulations and the number of consecutively affected years in the Chronicle of Michael the Syrian. Single year disasters are significantly more common in the random distribution while three consecutive disastrous years are more than three times as common in Michael's Chronicle than they are in the randomly generated distributions.

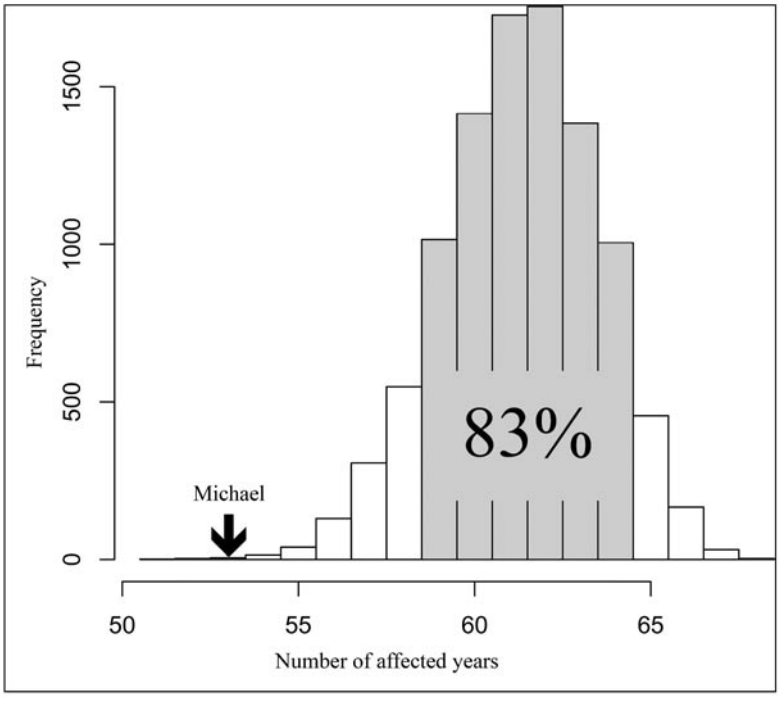


FIGURE 2. Independent distribution of 68 disasters over 276 years using 10,000 simulations (two identical disasters cannot occur in the same year). The arrow indicates the distribution in Michael the Syrian

and its effects on, among others, Mesopotamian societies, Harvey Weiss raises the important question of when we may assume that crop failure and reduced agro-production result in permanent changes to human societies. This question, of course, depends largely on the socio-economic structures of the affected societies. The high frequency of constantly reoccurring disasters recorded in the Chronicle of Michael the Syrian demonstrates the resilient character of the settlements in northern Syria and the Jazira. While any natural disaster in this region may have caused severe implications for independent households, the settlements as a whole would be able to deal even with extremely catastrophic years as long as they were followed by more regular years. Only a series of consecutive years with disasters would be able to affect an entire community on a more permanent level.[10]

From Table 2 it becomes clear that severe winters were the most frequent disaster followed by plagues of locusts and droughts (especially if we include here references to 'snow' and 'freeze' as well). The extreme cold could kill animals and wither and sometimes kill trees, both of which would have long-term

effects on the economy. The olive tree, for example, is extremely slow-growing but very long-lived (trees produce good yields for 50 years or more). It would take a settlement very long to recover from the losses of its olive trees.

On some occasions, the cold would freeze all available water, a condition that could rapidly cause animals to die of thirst (for example the winters of 1173/74 and 1175). For example, a modern donkey requires 15–30 litres of unfrozen water per day and will not break any layer of ice on water because of its sensitive nose. A dehydrated donkey might not drink even if dehydrated. It will become fussy with its food and eventually stop eating all together. It was not only the winter deep-freeze that affected livestock such as donkeys, but also the general harsh conditions of winter could adversely affect animals and their owners. In his article on the life in the Balikh valley, Norman Lewis quotes the British Consul's economic report of the Vilayet of Aleppo for the year 1911, which describes the terrible winter of 1910/11. In January severe frost set in, accompanied by heavy falls of snow, which continued for nearly two months. Sheep and their shepherds are reported to have perished in the snow. According to the report, 80 per cent of the sheep in the entire Vilayet of Aleppo died of cold and hunger. Despite the cold winter and the snow, the harvest of 1911 was reported to have been 'fairly good'. This devastating report is very much in accordance with reports of severe winters and the deaths of animals in the Chronicle of Michael the Syrian (i.e. the winters of 684, 768/69, 1173/74 and 1175).[11]

Large losses of labour or draught animals would have long lasting effects on the economy. Moreover, such losses would restrict the possibilities of transporting grain and other commodities from one region to another and lack of traction and labour would certainly exacerbate any agrarian crisis. During the devastating plague in 543–44 as well as during the three successive severe winters of 750/51–752/53 many fields were simply unharvested.[12]

In the cuneiform texts from ancient Mesopotamia, severe winters and cold weather with snow and frost is a common topic. Moreover, several different accounts from various periods and regions reveal the severity and often devastating effects of cold weather in antiquity. In a letter from the later part of the second millennium B.C. addressed to the king of Ugarit in north-western Syria from one of his generals, we learn of a five month long cold spell that was destroying chariots, killing horses and exhausting the troops (*Ugaritica V* 20 lines 27–8). A similar concern over the vulnerability of horses in extreme cold is found in a contemporary letter from the Hittite king Hattusili III to the Kassite king Kadashman-Enlil II in Babylon (*KBo I* 10 line 64). In this long letter, the land of Hatti in Anatolia is described as a land with severe winters where old horses are unable to survive. In addition, an analogous reference to severe cold in a fragmentary letter from the Neo-Assyrian period, dated to the eighth century B.C., should be mentioned. This letter, which was discovered in Nimrud just north of Assur, describes severe cold weather killing both troops and horses.

Another so-called Nimrud Letter (*CTN 5* 316 = *ND* 2777) describes how severe snow in early shabat (Month XI, January-February) made the roads to Kalhu (ancient Nimrud) impossible to travel. These examples are all somehow connected to warfare, and the concern is therefore placed on troops, chariots, roads and horses rather than on regular people, farms and livestock. However, a few other texts offer some glimpses of the very real concern people had regarding severe winters and cold. Hence an Old Babylonian letter discovered in Sippar, located about 35 kilometres southwest of modern Baghdad, where Iltani – the author of the letter – ends his letter by describing his predicament as follows: 'I am starving and the cold has prostrated me.'[13]

These numerous attestations in the cuneiform record show that cold winters were a major concern in northern Syria and Mesopotamia for both humans and animals throughout antiquity, very much in accordance with the numerous reports of severe and devastating winters described in the Chronicle of Michael the Syrian.

Almost as frequent as severe winters, and one of the most devastating natural disasters in northern Syria and the Jazira, were plagues of locusts. Ruinous swarms of locusts – the Eighth Plague of Egypt (Exodus 10:12–15) – are known to have been ravaging Syria since the beginning of history. A group of letters dated to the Old Babylonian king Zimri-Lim of Mari shows that the eastern parts of Syria suffered from two locust infestations that lasted for at least two consecutive years each during the first half of the eighteenth century B.C. Swarms of locusts appear in early spring when the crops are ripening and can destroy an entire year's harvest. In addition, the locusts will devour seeds and vegetables and ravage trees and orchards. In some years (that is 1081, 1121, 1135 and 1136) invasions of locusts are recorded to have done only little or no damage. The exact nature of these harmless outbreaks remains unclear. In some cases, outbreaks or upsurges of locusts do not lead to more serious plagues because of poor rainfall or migration to unfavourable areas. Two kinds of locusts can cause plagues in western Asia.[14]

The Moroccan locusts (*Dociostaurus maroccanus*, Thunb.) will eat anything and appear in temporary breeding areas where they increase extremely rapidly. The females lay their eggs in spring or early summer in bare, often stony, areas located in the lower slopes of bordering mountains. The eggs will hatch some ten months later in the spring of the following year when the crops are green (for example the years 713–714, 804–805–806–807, 830/31–831/32). Wolfgang Heimpel has suggested the ranges of the *Jabal Sinjar* and *Jabal Abd al-Aziz* to the east and west of the Habur river in north-eastern Syria, or *Tur Abdin* in southeast Turkey, as possible hatching areas for the Moroccan locust in the Old Babylonian period. Since infestations are known to spread concentrically up to two hundred kilometres from the original hatching areas, this would mean that almost the entire region of northern Syria and the Jazira could have been regularly affected by swarms of Moroccan locusts in this period. Today, the Moroccan

locusts have permanent breeding areas in the Habur area and all over central Anatolia. One of the most famous references to locusts in ancient Mesopotamia is a metaphor of the invading Gutians in the Curse of Agade. The text is a poetic narrative written during the Ur III period (2111–2003 B.C.), or perhaps even earlier, describing the fall, destruction, and ultimate curse of the Akkadian capital and state. Because of the sacrilegious deeds of king Naramsin of Akkad, the god Enlil summoned the fierce Gutians from the distant mountains to invade the land (lines 157–8): 'Enlil brought them (the Gutians) from the mountains, like hordes of locusts, they covered the earth'. The fact that this hostile invasion into Mesopotamia from the mountains was poetically described as an invasion of locusts, suggests that locust infestations in Mesopotamia were traditionally considered to originate in mountainous regions. This would fit nicely with the breeding habits of the Moroccan locust.[15]

The desert locust (*Schistocerca gregaria*, Forsk.) is less common in Syria but potentially even more devastating than the Moroccan locust to agricultural areas. It lives in its solitary phase in the arid and semi-arid areas of Africa, the Middle East, and southwest Asia. Gregarious locusts migrate in very large swarms. They invade new regions far outside their recession habitat and can cause extreme damage to crops and pasture over huge areas. The desert locusts also appear in the spring but unlike the Moroccan locusts, their eggs have a very short incubation period of 10–65 days depending on soil temperatures. The larval period (hopper stage) lasts 30–40 days and is often devastating to crops, which are still green when marching bands of hungry hoppers are formed. The females lay their eggs in bare areas of slightly moist and sandy soil in intervals of 6–11 days. Because the laying takes place in intervals, the eggs do not hatch at the same time, and swarms may contain locusts in various stages of development. The new generation desert locusts (the fledglings and adults) will devour the same crops as the earlier generation and those that ripen later in the year.[16]

The frequency of locust infestations recorded by Michael the Syrian can be compared to more modern data. According to Michael the Syrian, northern Syria and the Jazira were invaded by locusts roughly every 23 years (at three separate occasions the infestations lasted for two consecutive years). This can be compared to data on infestations in Israel between 1860 and 1960 when seven outbreaks were recorded for the years 1865, 1878, 1900–1902, 1915, 1928–1930, 1941–1944, 1959–1960. Thus, the outbreaks in nineteenth and twentieth century Israel occurred, on the average, roughly every 14 years, significantly more often (and for more prolonged periods) than Michael the Syrian recorded for northern Syria and the Jazira. The average number of years between the outbreaks in Israel was 13.5 years (with a standard deviation of only 3.89). The regularity of the outbreaks is remarkable, and it has been suggested that locust invasions in the Near East are periodic events occurring every 11 to 13 years. However, the idea of such inherent breeding cycles should be rejected, and the outbreaks recorded by Michael the Syrian do not suggest any periodicity. The number of uninfested

years between the outbreaks in Michael the Syrian's Chronicle vary from 1 to 74 years with an average of 22.6 years (standard deviation: 25.64).[17]

Finally, severe droughts should be mentioned as one of the most frequent reasons for widespread famines in northern Syria and the Jazira in Michael the Syrian's Chronicle. Not only could the lack of rain ruin vegetables and crops but it could also completely dry up the springs and rivers and cause people and animals to die of thirst (for example, the years 721/22 or 1148). According to Marten Stol, the Akkadian word for drought is *ublum*. Only a few Old Babylonian letters and other texts from the early second millennium B.C. are concerned with droughts and the effects of drought. In the fragmentary letter *AbB* 5 198 discovered in Nippur in southern Mesopotamia, the author of the letter pleads that the 'young men (or servants) should not die through drought'. In another letter of complaint, the author laments 'I will die through famine and drought.' Finally, an Old Babylonian incantation addressed to the god Enki concerning the effects of black magic, enumerates various disasters being endured: 'he has cast over me famine, thirst, drought, cold and misery'. The particular enumeration in this text of drought and cold is worthy of note, and may imply that these different disasters were associated in the ancient world.[18]

DISCUSSION

The data from the Chronicle of Michael the Syrian suggest that climatic and agricultural disasters were very common in northern Syria and the Jazira in antiquity. On the average, about 1 year in 5 was affected with one or several catastrophes in the Chronicle. The most common and serious disasters were severe winters, plagues of locusts and droughts, which each occurred on the average roughly every 20 years. How were the ancient settlements able to handle frequent catastrophes and disasters that constantly occurred in this marginal area of northern Syria and the Jazira?

Many of the climatic or environmental catastrophes enumerated by Michael the Syrian, such as extreme droughts or plagues of locusts, could affect several or all aspects of the economy. However, other catastrophes could be devastating to one or a few sectors of the economy while they apparently did little or no *direct* damage to other areas of the economy. As an example of the latter type of disaster, extremely cold winters can be mentioned. Severe winters and cold weather could kill large numbers of animals and trees, but such winters were often followed by normal, or even exceptional, harvests. Other studies have shown that there is a strong association between cold winters and increased average annual rainfall in the Middle East, and only once during the 276 years discussed in this article do we find evidence that colder winters coincided with droughts; according to Michael the Syrian, the year 1135 was affected by a drought that had started already in 1133. This long drought was immediately

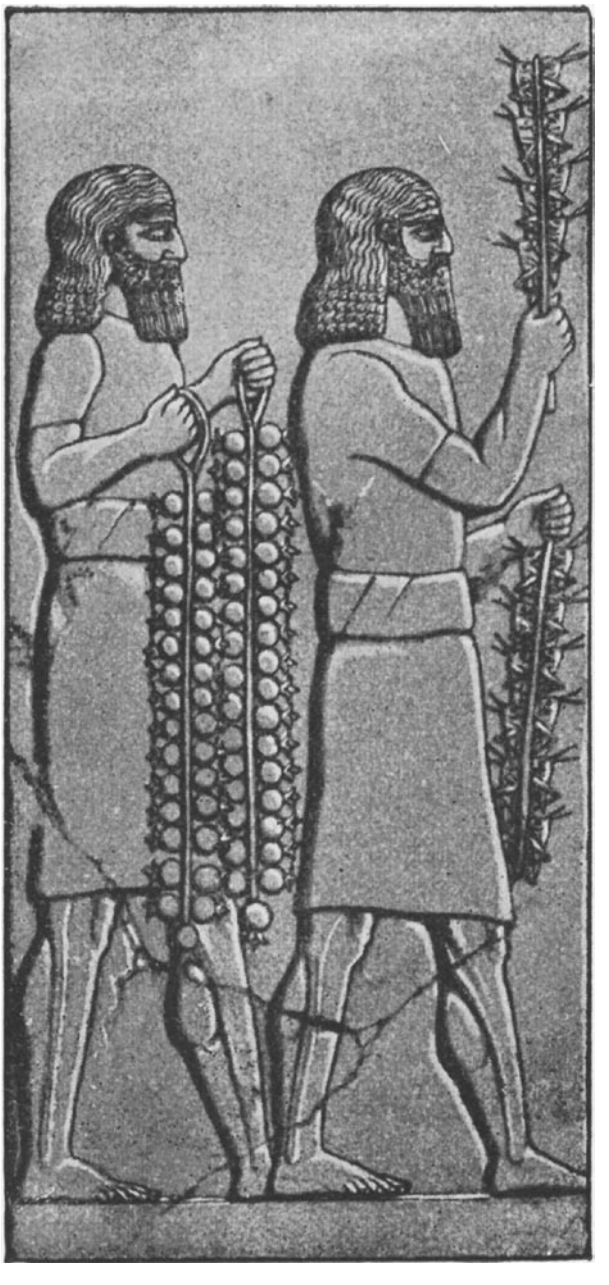


FIGURE 3. Relief from the palace of Sennacherib (704–681 B.C.) with locusts and other foodstuff prepared for the grill (Bruno Meissner, *Babylonien und Assyrien*, Erster Band (Heidelberg: Carl Winter, 1920), Abb. 45)

followed (and alleviated?) by the severe winter of 1135/36.[19]

Years with warm winters would be beneficial to the social organisation based on livestock raising, but such years would also be more likely to experience extremely dry weather resulting in crop failures. Although the economy of the settlements in northern Mesopotamia was based on cereal farming, there can be no doubt that sheep and goat herding (both nomadic and sedentary) played a crucial role in the region. The animals themselves served as a necessary store of grain surplus from years with good harvests for the constantly reoccurring bad years. Moreover, a diversified subsistence of the settlements was essential in order to absorb some of the risks that life in this marginal semiarid environment involved.[20]

Large swarms of locusts could be devastating to cultivated fields, pasture, and even trees, and would therefore have devastating effects on every aspect of the economy. However, it should be noted that the locust itself is extremely nutritious. Around 62 per cent of the dry weight of an adult desert locust consists of protein and around 17 per cent of fats. In many parts of the Near East, locusts are eaten during periods of increased locust activity, and this may, at least to some extent, counteract widespread famine, especially since locusts can be dried and eaten later. Indeed, cuneiform texts and iconographic material show that roasted locusts were considered a delicacy in ancient Mesopotamia.[21]

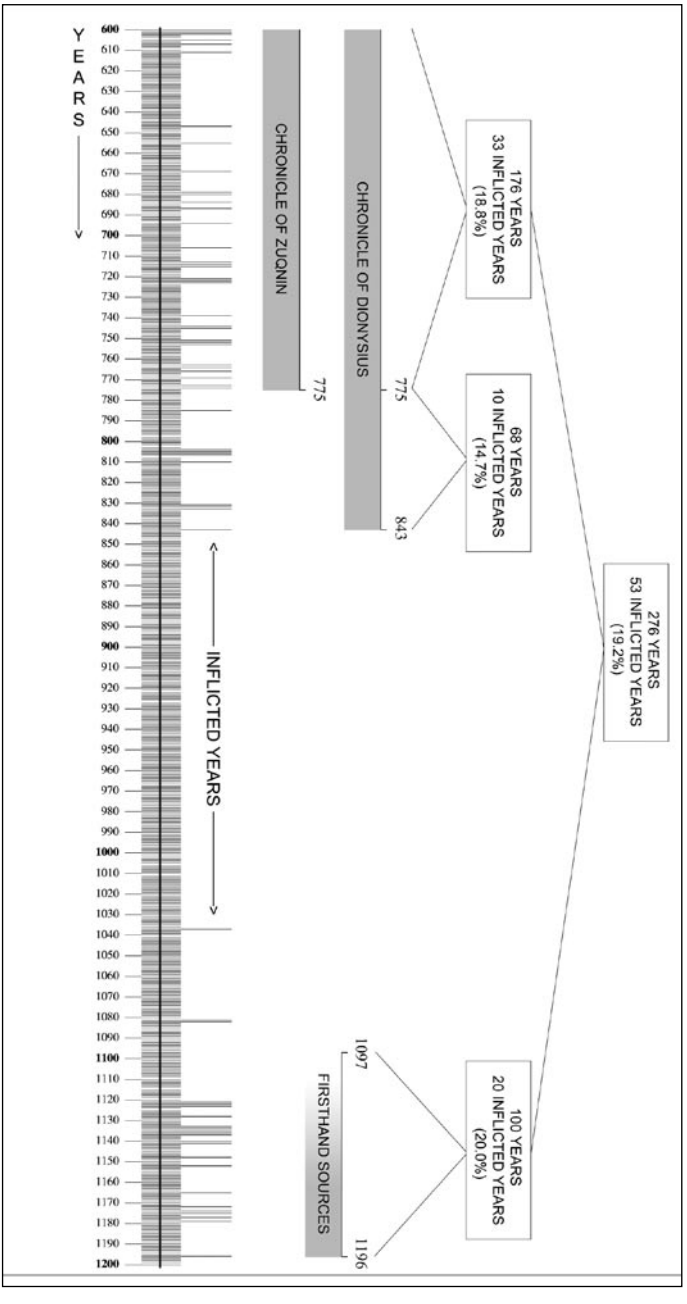
The local character of some of the disasters described by Michel the Syrian is noteworthy and it seems possible that transports of grain between different villages and regions could have been used to relieve severely hit areas. Jeanette C. Fincke has recently suggested that overland transports of agricultural produce in the Nuzi state may have been initiated to help specific areas with crop failures. Such potential relief transports should be taken into account in any reconstructions of early interregional transports of grain, and may suggest that the functionalistic position that transports on land (by pack animals either alone or pulling carts) of grain in northern Mesopotamia in the third millennium were uneconomic, and therefore of insignificant importance, should be reconsidered. Moreover, as already noted by Gil Stein, the environment and climate of the north made urbanism 'a risky business'. A flexible and more dispersed settlement pattern with smaller rural settlements, rather than a few larger towns, makes more sense in an environment of local catastrophes. [22]

CONCLUSIONS

In the scenario proposed by Harvey Weiss et al., the collapse of urban-scale settlements in northern Syria in the late third millennium is explained by an extreme aridification which resulted in recurring droughts. The aridification reduced agro-production and ultimately led to site and regional abandonment of the rain-fed agricultural zone of northern Iraq and Syria. The data derived

from the Chronicle of Michael the Syrian confirm that drought indeed was a recurring threat to the farmers in northern Syria and the Jazira, even in a period of more normal climatic conditions. However, ancient references to droughts in this region are surprisingly rare. In fact, in both the Chronicle of Michael the Syrian and in the cuneiform text record, references to locust infestations or, in particular, extremely cold weather are far more frequent than the references to droughts. Extreme winters with snow and frozen rivers appear to have been equally – or even more – devastating to the region. More importantly, the negative effects of extremely bad winters would be suffered for several consecutive years, since they would kill trees and animals. The losses of trees and draught animals would have long lasting effects on the agricultural production while widespread losses of sheep and goats would completely exhaust several years of collected agricultural surplus. While severe droughts are likely to increase in frequency during a period of aridification and cooling, so are severe winters, and the data suggests that winters and cold weather may have been an equally serious threat to the populations of northern Syria and the Jazira, especially when such winters were not followed by any intensification of annual precipitation. The extended catastrophic results of cold winters and the negative effects on several different aspects of the economy are extremely important. The constantly recurring catastrophes enumerated by Michael the Syrian demonstrate the resilient nature of the settlements in this region in antiquity. It seems clear that only a recurrent series of several extreme disasters would cause permanent changes to the settlement patterns of the region, especially if several important aspects of the economy were affected simultaneously.

APPENDIX 1: Years affected with catastrophes in northern Syria and the Jazira 600–1196



APPENDIX 2: Summary of disasters in northern Syria and the Jazira 600–1196

Year	**Disaster**	**Claimed Results**	**Sources**[23]
600–601	Drought; Storm wind	Olives and other trees withered	Michael
Spring 602	Locusts	Destroyed seeds and fruits	Michael
Spring 605	Locusts	Famine	Michael
607	Severe winter	Euphrates froze; Seeds and trees withered	*Michael*
611	Drought	Crops perished; Famine	*Michael*
647	Storm wind	Trees uprooted	*Michael*
655		Lack of grain; Famine	*Michael*
669	Severe winter	Olives, other trees, vines withered	*Michael*
678/79	Rats	Destroyed seeds; Famine	*Michael*
Spring 680	Locusts		*Michael*
684	Severe winter	Olives, vines withered; People, animals died of cold	*Michael*
687		Lack of grain; Famine	*Michael*
694	Drought	Lack of grain; Famine	*Michael*
706	Freeze	Olives, vines withered	*Michael*
Spring 713	Locusts; Storm wind	Trees uprooted by the wind	*Michael*
April 714	Freeze	Trees, plants, vines withered	*Michael*
May 714	Locusts	Destroyed fields, plants, vines	*Disasters*
714	Drought		*Disasters*
Spring 715	Hail	Killed animals, including camels and donkeys	*Disasters*
Spring 721	Locusts	Destroyed olives, figs, vines	*Michael*
721/22	Drought	Springs, rivers dried up; Lack of grain, vegetables; Desertation of many places	*Michael*
Spring 723	Locusts	Destroyed harvest; Famine	*Michael*
Spring 739?	Flood	Presumably, *Michael* and *Zuqnin*/*Dionysius* are here referring to the same eventful year. According to Morony (2000, §7, n. 28), *Zuqnin* is notoriously cavalier about chronology.	*Michael*
742/43?	Severe winter; Storm wind; Flood		*Zuqnin; Dionysius*
744–45 *Zuqnin*: 743	Severe winter	Severe Famine; Epidemic bubonic plague	*Michael*
750/51–752/53	3 Severe winters; Locusts; Mildew; Weevils	Rivers froze, Damage to vines, olive trees, gardens, seeds; Pests damage vines, trees, fruit, wheat; Many fields unharvested; Famine	*Zuqnin*
Spring 763	Locusts	Destroyed seeds	*Michael*
763–64	Plague	Killed horses	*Zuqnin; Dionysius*
Spring 766	Locusts	Destroyed seeds	*Michael*
768/69	Snow	Killed cattle, sheep	*Zuqnin; Dionysius*
772/73	Drought	No winter rain, ruined the crop	*Zuqnin*
Fall 773	Snow; Hail	Ruining vines, trees	

Year	Disaster	Claimed Results	Sources[23]
773/74	Severe winter	Destroyed vines and withered trees (Olive, Fig, Apple, Pomegranate, Palm)	Zuqnin
Spring 785	Locusts	Destroyed all crops and vegetables; Famine	Michael
Spring 804	Locusts	Destroyed all crops	Michael
Spring 805	Locusts	Destroyed crops; Famine	Michael
Spring 806	Locusts	Destroyed crops; Famine	*Michael*
Spring 807	Locusts	Destroyed crops; Famine	*Michael*
Jan 810 ?	Storm wind	All vine, grain, fruits destroyed	*Michael*
830 or 831	Hail; Locusts	Destroyed crops; Locusts destroyed vines, olive trees	*Michael*
831 or 832	Locusts	Destroyed crops, vine, trees	*Michael*
833		Lack of grain; Famine	*Michael*
842/43	Snow; Freeze	Seeds fail to germinate; Famine; Disease	*Michael*
843	Hail; Locusts	Destroyed seeds, crops; Famine; Disease	*Michael*
1037		Lack of grain; Famine	*Michael*
Spring 1081	Locusts	Little damage	*Michael*
1082		Lack of grain, vines; Famine	*Michael*
Spring 1121	Locusts	Little damage	*Michael*
1121/22	Severe winter	Rivers froze	*Michael*
1123	Drought	Famine that lasted until 1125	*Michael*
1127/28	Severe winter		*Michael*
1133–35	Drought	Famine	*Michael*
Spring 1135	Locusts	No damage to the crops	*Michael*
1135/36	Severe winter		*Michael*
Spring 1136	Locusts	No damage	*Michael*
1136/37	Severe winter; Snow	Rivers froze	*Michael*
1139/40	Severe winter	Rivers froze; Late harvest	*Michael*
May 1141	Hail	Ruin vines, trees	*Michael*
June 1141	Storm wind	Trees uprooted	*Michael*
1141	Plague	Killed chickens	*Michael*
1148	Drought	Springs dried up; Desertation of many places	*Michael*
1151/52	Snow; Rain	Destroyed seeds, crops	*Michael*
1165		Lack of wheat	*Michael*
1172	Freeze; Snow	Ruin vines, olives, sesame, crops	*Michael*
1173/74	Severe winter	All water froze; Thirst; Famine	*Michael*
1175	Severe winter	All water froze; Cattle, donkeys, horses died; Thirst; Famine	*Michael*
1177	Drought	Destroyed seeds, grain; Desertation of places; Famine	*Michael*
1178/79	Drought	Destroyed grain; Famine	*Michael*
Spring 1196	Locusts	Destroyed grain, vines	*Michael*

NOTES

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References to cuneiform texts in this article follow the abbreviations and conventions used in *The Assyrian Dictionary of the Oriental Institute of the University of Chicago* (Chicago and Glückstadt: The Oriental Institute, 1956ff.) and Wolfgang Von Soden, *Akkadisches Handwörterbuch* (Wiesbaden: Otto Harrassowitz, 1959–74) (hereafter *CAD* and *AHw*).

[1] For a most recent study on the profound impact that environment has on practically everything, see Shepard Krech III, J.R. McNeill and Carolyn Merchant (eds.), *Encyclopedia of World Environmental History*, 3 vols. (New York: Routledge, 2004); see also the extensive review by Ted Steinberg, 'Fertilizing the Tree of Knowledge: Environmental History Comes of Age', *Journal of Interdisciplinary History* 35/2 (2004): 265–77, emphasising the unnatural aspects of many historical 'natural' disasters. For the climate of northern Syria and the Jazira in the Bronze Age, see, for example, Hasan Nüzhet Dalfes, George Kukla and Harvey Weiss (eds.), *Third Millennium BC Climate Change and Old World Collapse*, NATO ASI Series I: Global Environmental Change 49 (Berlin: Springer-Verlag, 1997); H. Weiss, M.-A. Courty, W. Wetterstrom, F. Guichard, L. Senior, R. Meadow and A. Curnow, 'The Genesis and Collapse of Third Millennium North Mesopotamian Civilizations', *Science* 261 (1993), 995–1004; Harvey Weiss, 'Beyond the Younger Dryas: Collapse as Adaptation to Abrupt Climate Change in Ancient West Asia and the Eastern Mediterranean', in *Environmental Disaster and the Archaeology of Human Response,* ed. Garth Bawden and Richard Martin Reycraft (Albuquerque: Maxwell Museum of Anthropology, University of New Mexico, 2000), 75–98; Marie-Agnes Courty and Harvey Weiss, 'The Scenario of Environmental Degradation in the Tell Leilan Region, Ne Syria, During the Late Third Millennium Abrupt Climate Change', in *Third Millennium BC Climate Change and Old World Collapse*, ed. Hasan Nüzhet Dalfes, George Kukla and Harvey Weiss, NATO ASI Series I: Global Environmental Change 49 (Berlin: Springer-Verlag, 1997), 107–47. Note, however, a general settlement increase – rather than decrease – that appears to have taken place in some areas of northern Syria at the end of the third millennium B.C. (T.J. Wilkinson, *Excavations at Tell Es-Sweyhat, Syria, Volume 1: On the Margin of the Euphrates: Settlement and Land Use at Tell Es-Sweyhat and in the Upper Lake Assad Area, Syria* [Chicago: The Oriental Institute, 2004], 193).

For numerous climate changes in the mid-to-late Holocene in northern Syria, see Frank Hole, 'Evidence for Mid-Holocene Environmental Change in the Western Khabur Drainage, Northeastern Syria', in *Third Millennium BC Climate Change and Old World Collapse*, op.cit., 39–66, 41; see also J. Neumann and Simo Parpola, 'Climate Change and the Eleventh-Tenth-Century Eclipse of Assyria and Babylonia', *Journal of Near Eastern Studies* 46 (1987), 146–82; and Burchard Brentjes, 'Kaltzeiten und Völkerbewegungen. Thesen zum Zusammenhang von Klimaschwankungen und Völkerbewegungen im späten

2 Jahrtausend v. Chr.', in *Landwirtschaft im Alten Orient*, ed. Horst Klengel and Johannes Renger, Berliner Beiträge zum Vorderen Orient 18 (Berlin: Dietrich Reimer Verlag, 1999), 59–63. For a balanced discussion of climate change and its potential impact on site and regional abandonment, see Richard L. Zettler, 'Reconstructing the World of Ancient Mesopotamia: Divided Beginnings and Holistic History', *Journal of the Economic and Social History of the Orient* 46 (2003), 3–45; Karl W. Butzer, 'Sociopolitical Discontinuity in the Near East C. 2200 B.C.E.: Scenarios from Palestine and Egypt', in *Third Millennium BC Climate Change and Old World Collapse*, op.cit., 245–96.

[2] Gil J. Stein, 'Structural Parameters and Sociocultural Factors in the Economic Organization of North Mesopotamian Urbanism in the Third Millennium B.C.', in *Archaeological Perspectives on Political Economies*, ed. Gary M. Feinmann and Linda M. Nicholas (Salt Lake City: University of Utah Press, 2004), 61–83, 62, with data from Harvey Weiss 'The Origins of Tell Leilan and the Conquest of Space in Third Millennium Mesopotamia', in *The Origins of Cities in Dry Farming Syria and Mesopotamia in the Third Millennium BC*, ed. Harvey Weiss (Guilford: Four Quarters Publishing Co., 1986), 71–108, 77; see also T.J. Wilkinson, 'The Structure and Dynamics of Dry-Farming States in Upper Mesopotamia', *Current Anthropology* 35 (1994), 483–520, 499–500.

[3] For a most recent study on the effects of the industrialisation and increased atmospheric CO_2 levels on climate and agriculture, see José Luis Araus, Gustavo Ariel Slafer, Ramon Buco and Ignacio Romagosa, 'Productivity in Prehistoric Agriculture: Physiological Models for the Quantification of Cereal Yields as an Alternative to Traditional Approaches', *Journal of Archaeological Science* 30 (2003), 681–93, 683.

[4] For a general picture of dry-farming agriculture in northern Syria and the Jazira in antiquity, see Stein 'Structural Parameters', 67–8; with further references; see also Katleen Deckers, 'Anthracological Research at the Archaeological Site of Emar on the Middle Euphrates, Syria', *Paléorient. Revue pluridisciplinaire de préhistoire et protohistoire de l'Asie du Sud-Ouest et de l'Asie centrale* 31/2 (2005), 153–67. For the cultivation of barley, wheat and emmer in the cuneiform texts from Tell Beydar, see Magnus Widell, 'Some Observations on the Administration, Agriculture and Animal Management of Tell Beydar', *Ugarit-Forschungen. Internationales Jahrbuch für die Altertumskunde Syrien-Palästinas* 35 (2004), 717–33, 724–26; for wine or grapes in Tell Beydar, see Walther Sallaberger and Philippe Talon, 'Transliterated Texts', in *Administrative Documents from Tell Beydar (Seasons 1993–1995)*, ed. Farouk Ismail, Walther Sallaberger, Philippe Talon and Karel Van Lerberghe, Subartu 2 (Turnhout: Brepols, 1996), 127–74, 130 (text no. 6). For the cultivation of olives in Ebla, see Hartmut Waetzoldt, 'Ölpflanzen und Pflanzenöle im 3. Jahrtausend', *Bulletin on Sumerian Agriculture* 2 (1985), 77–96, 77 and 79–80; Alfonso Archi, 'Culture de l'olivier et production de l'huile à Ebla', in *Marchands, diplomates et empereurs. Études sur la civilization Mésopotamienne offertes à Paul Garelli*, ed. Dominique Charpin and Francis Joannes (Paris: Éditions Recherche sur les Civilisations, 1991), 211–22.

[5] Michael G. Morony, 'Michael the Syrian as a Source for Economic History', *Hugoye: Journal of Syriac Studies* 3 (2000), available from http://syrcom.cua.edu/Hugoye/. Although Michael's chronicle records ravaging or pillaging at the hands of humans, such data cannot be applied on the completely different cultural and political setting of the third millennium B.C., and this information has not been included in this analysis (hence Michael's report on Muslims killing pigs in 994 or 820). Nevertheless, it should be stated that conflicts, wars and ravaging groups also constituted an additional constant

threat to the farmers of the third millennium B.C. It goes without saying that this threat became more serious in times of famine, when large groups in the society were unable to produce food by peaceful means and when the settlements were less able to defend themselves. See further Neumann and Parpola, 'Climate Change and the Eleventh-Tenth-Century Eclipse', 161.

[6] For an outline of the life of Michael the Syrian (sometimes referred to as Michael the Great, see Dorothea Weltecke, 'The World Chronicle by Patriarch Michael the Great (1126–1199): Some Reflections', *Journal of Assyrian Academic Studies* 11 (1997), 6–30, 17); see also Abdulmesih BarAbrahem, 'Patriarch Michael the Great: Beyond his World Chronicle', *Journal of Assyrian Academic Studies* 12 (1998), 33–45, 33–8.

[7] For a recent, more comprehensive, study of the historical and narrative reliability of the Chronicle of Michael the Syrian, see Dorothea Weltecke, 'Originality and Function of Formal Structures in the Chronicle of Michael the Great', *Hugoye: Journal of Syriac Studies* 3 (2000), available from http://syrcom.cua.edu/Hugoye/. For the sources used by Michael the Syrian, see also BarAbrahem, 'Patriarch Michael the Great', 41–3. For the Chronicle of Zuqnin – presumably an eighth-century monk at the monastery of Zuqnin in Tour Abdin – see Amir Harrak, *The Chronicle of Zuqnin, Parts III and IV, A.D. 488–775* (Toronto: Pontificial Institutute of Mediaeval Studies, 1999); Witold Witakowski, *The Syriac Chronicle of Pseudo-Dionysius of Tell-Magre. A Study in the History of Historiography* (Uppsala: Almqvist & Wiksell International, 1987); Witold Witakowski, *Pseudo-Dionysius of Tel-Mahre, Chronicle, Part III* (Liverpool: Liverpool University Press, 1996). For John of Ephesus, sometimes referred to as John of Asia, see further Morony, 'Michael the Syrian', §5; Susan A. Harvey, 'Theodora the "Believing Queen": A Study in Syriac Historiographical Tradition', *Hugoye: Journal of Syriac Studies* 4 (2001), §§16–18, §30, available from http://syrcom.cua.edu/Hugoye/. As for the unreliable nature of Michael the Syrian's account for the sixth century, it should be noted that Michael hardly seems to acknowledge the well-known and significant global event around 536–45, documented by David Keys, *Catastrophe. An Investigation into the Origins of the Modern World* (New York: Ballantine, 1999); and Joel D. Gunn, *The Years without Summer: Tracing A.D. 536 and its Aftermath*, BAR International Series 872 (Oxford: Archaeopress, 2000), with further literature.

[8] Josue = Chronicle of Josue the Stylite. Paulin Martin, *Cronique de Josue le Stylite*, Abhandlungen für die Kunde des Morgenlandes 6, Band 1 (Leipzig: Deutschen Morgenländischen Gesellschaft, 1876); Michael = Chronicle of Michael the Syrian. Jean-Baptiste Chabot, *Cronique de Michel le Syrien* (Paris: E. Leroux, 1899; rpt. edn., Bruxelles: Culture et Civilisation, 1963); Zuqnin = Chronicle of Zuqnin. Harrak, *The Chronicle of Zuqnin*.

[9] Hence, the locusts of the year 500, which are reported to have devoured everything from the territory of Assur to the Mediterranean and the land of Urtea in the north, or the outbreak of 1196, which affected the entire area from the borders of Egypt to Iberia and from Iran to the Black Sea (see Morony, 'Michael the Syrian', §19 and §23). There can be little doubt that such large infestations were caused by the desert locust (see below). For the climatic correlation between Syria and northern Mesopotamia, see Neumann and Parpola, 'Climate Change and the Eleventh-Tenth-Century Eclipse', 168–71.

[10] See Weiss 'Beyond the Younger Dryas', 91: 'First, precisely when does crop failure and reduced agro-production generate abandonment, habitat-tracking, nomadism, and system collapse, within various politico-economic systems and across various terrains

in Greece, Palestine, Egypt, Anatolia, Mesopotamia, and the Indus?'

[11] Norman Lewis, 'The Balikh Valley and its People', in *Hammam Et – Turkman I. Report on the University of Amsterdam's 1981–84 Excavations in Syria II*, ed. Maurits N. Van Loon (Leiden: Nederlands Instituut voor het Nabije Osten, 1988), 683–95, 689. For the report, which was unavailable to me, see Raff A. Fontana, *Report for the Year 1911 on the Trade and Commerce of the Vilayet of Aleppo*. Parliamentary Papers, Vol. C, 1912–13 (1912).

[12] For the important role of donkeys and other draft animals in the agricultural production in northern Syria in the Bronze Age, see Widell, 'Some Observations on the Administration, Agriculture and Animal Management of Tell Beydar', 717–33.

[13] For numerous references to winters, frost and cold weather, see *CAD* and *AHw* under *e/arijātu, ḫalpû, ḫurbāšu, kuppû, kuṣṣu/kūṣu, mammû, šalgu, šurīpu, šuruppû, takṣâtu*. Other related disasters described by Michael the Syrian, such as hail, is also well attested (see *CAD* under *abnu* A6 and *AHw* under *tīku* 2c).

For a recent English translation of *KBo I* 10, see Gary Beckman, *Hittite Diplomatic Texts, Second Edition* (Atlanta: Scholars Press, 1999), 138–43. For the Neo-Assyrian letter describing cold weather killing troops and horses, see H. W. S. Saggs, 'The Nimrud Letters, 1952–Part V', *Iraq* 21 (1959), 158–80, 172 (text LXI). Additional Neo-Assyrian letters referring to extreme cold and its effect on livestock, plants and roads can be found in Govert Van Driel, 'Weather: Between the Natural and the Unnatural in First Millennium Cuneiform Inscriptions' in Diederik J.W Meijer (ed.) *Natural Phenomena. Their Meaning, Depiction and Description in the Ancient Near East* (Amsterdam, 1992), 39–52, 47–49. Note also the Old Babylonian letter *ARM 16* 7, which describes a brief but devastating hail storm that destroyed agricultural fields in north-eastern Syria. The letter was written by Yaqqim-Addu, governor of the province of Sagarâtum in the Habur area, to the famous king Zimri-Lim in Mari (1779-1757 B.C.). For the correct interpretation of this text, see Jean-Marie Durand, 'Trois etudes sur Mari', *Mari Annales de Recherches Interdisciplinaires* 3 (1984), 127–80, 137.

[14] For these ancient plagues of locusts in Syria, see Wolfgang Heimpel, 'Moroccan Locusts in Qattunan', *Revue d'assyriologie et d'archéologie orientale* 90 (1996), 101–20; Brigitte Lion and Cécile Michel, 'Criquets et autres insectes à Mari', *Mari Annales de Recherches Interdisciplinaires* 8 (1997), 707–24; Niele Ziegler's extensive review of Maurice Birot, *Correspondance des gouverneurs de Qattunân*, ARM 27 (Paris: Éditions Recherches sur les Civilisations, 1993), in *Archiv für Orientforschung* 46–47 (1999/2000), 324–36, 328–30.

[15] For a detailed description of the development stages, general behaviour, and habitat of the Moroccan locust, see Boris P. Uvarov, 'Ecology of the Moroccan Locust in Iraq and Syria', *Bulletin of Entomological Research* 24 (1933). For a translation and commentary of the Curse of Agade, see Jerrold S. Cooper, *The Curse of Agade* (Baltimore and London: Johns Hopkins University Press, 1983); for the passage in this text concerning locusts, see also Wolfgang Heimpel, *Tierbilder in der sumerischen Literatur* (Rome: Papstliches Bibelinstitut, 1968, 446.

[16] For a detailed description of the development stages, general behaviour, and habitat of the desert locust, see Philip. M. Symmons and Keith Cressman, *Desert Locust Guidelines. 1. Biology and Behaviour* (Rome: Food and Agriculture Organization of the United Nations, 2001, Second edition), available from http://www.fao.org/ag/locusts/oldsite/PUBS1.htm; Ezekiel Rivnay, *Field Crop Pests in the Near East* (The Hague: W. Junk, 1962).

[17] For periodicity of locust outbreaks in Israel in the nineteenth and twentieth century, see Rivnay, *Field Crop Pests in the Near East*, 30. All the outbreaks in Israel took place during global plagues of the desert locust: 1861–67, 1869–81, 1889–1910, 1912–19, 1926–34, 1940–48, 1949–63 (Symmons and Cressman, *Desert Locust Guidelines*, 36–7).

[18] Marten Stol, 'ublum "drought"', *Nouvelles Assyriologiques Breves et Utilitaires* 2001/1 (2001), no. 5. For the OB letter of complaint, see Farouk N.H. Al-Rawi and Stephanie Dalley, *Old Babylonian Texts from Private Houses at Abu Habbah, Ancient Sippar. Baghdad University Excavations*, EDUBBA 7 (London: NABU Publications, 2000), no. 117. For the OB incantation, see Gary Beckman and Benjamin R. Foster, 'An Old Babylonian Plaint against Black Magic', *Acta Sumerologica* 18 (1996), 19–21. In addition to these early references to drought, a Neo-Assyrian report from the seventh century B.C. describing how insufficient precipitation resulted in a completely failed cereal harvest should be mentioned. For an analysis of this report (*LAS* 300 + 109), see Govert Van Driel, 'Weather: Between the Natural and the Unnatural in First Millennium Cuneiform Inscriptions', in *Natural Phenomena. Their Meaning, Depiction and Description in the Ancient Near East: Proceedings of the Colloquium, Amsterdam, 6-8 July, 1989*, ed. Diederik J. W. Meijer (Amsterdam: North-Holland, 1992), 39–52, 50.

[19] For the connection between cold winters and increased annual rainfall, see J. Neumann and Marcel Sigrist, 'Harvest Dates in Ancient Mesopotamia as Possible Indicators of Climatic Variations', *Climatic Change* 1 (1978), 239–52, 241; Neumann and Parpola, 'Climate Change and the Eleventh-Tenth-Century Eclipse', 170–1.

[20] See T.J. Wilkinson, 'Settlement and Land Use in the Zone of Uncertainty in Upper Mesopotamia', in *Rainfall and Agriculture in Northern Mesopotamia. Proceedings of the Third MOS Symposium*, ed. Remko M. Jas, PIHANS 88 (Leiden: Nederlands Instituut voor het Nabije Osten, 2000), 3–35, 14–6, 19–20; Stein 'Structural Parameters', 67, 69–70.

[21] For textual evidence for the consumption of locusts from largely the Old Babylonian period (ca. 1900–1600 B.C.), see *CAD* under *erbu* b.

[22] Jeanette C. Fincke, 'Transport of Agricultural Produce in Arraphe', in *Rainfall and Agriculture in Northern Mesopotamia. Proceedings of the Third MOS Symposium*, ed. Remko M. Jas, PIHANS 88 (Leiden: Nederlands Instituut voor het Nabije Osten, 2000), 147–69; see further Wilkinson, 'Settlement and Land Use in the Zone of Uncertainty', 15–16, n. 13. On the advantages of a diversified economy in the marginal area of northern Mesopotamia, see Stein 'Structural Parameters', 77. For the settlement patterns of northern Mesopotamia, see T.J. Wilkinson, 'Regional Approaches to Mesopotamian Archaeology: The Contribution of Archaeological Surveys', *Journal of Archaeological Research* 8 (2000), 219–67.

[23] Dionysius = Chronicle of Dionysius of Tell Mahre. Jean-Baptiste Chabot, *Cronique de Denys de Tell-Mahré, Quatrieme Partie*. Bibl. Éc/ Hautes Études 112 (Paris: Bibliotheque de l'École, 1895); Disasters = Chronicle of Disasters. Sebastian P. Brock, 'A Chronicle of Disasters Dated AD 716', in Andrew Palmer *The Seventh Century in the West-Syrian Chronicles* (Liverpool: Liverpool University Press, 1993): 45–8; Michael = Chronicle of Michael the Syrian. Chabot, *Cronique de Michel le Syrien*; Zuqnin = Chronicle of Zuqnin. Harrak, *The Chronicle of Zuqnin*.