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Human-Climate Connection in North Central Iran Between 6000 and 2700 BCE

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Abstract

During the Holocene, man's challenges with climate entered a new phase. Holocene climatic cycles, by creating dry events, have imposed many subsistence tensions on water-dependent communities. The semi-arid and arid region of North Central Iran, which has been very vulnerable to any climate change, experienced unfavorable environmental conditions during these climatic events. So far, only a handful of Early Holocene rural settlements have been found in the region, possibly because of the mostly arid climate of the period. In general, the first evidence of Neolithic villages in North Central Iran dates back to the beginning of the Middle Holocene, after the 8.2 ka BP event. The first cultural flourishing of this region can be seen from the last quarter of the sixth millennium BCE. Each cultural flourishing period seems to have declined for some time with the occurrence of a dry event. The effects of climatic tensions on human societies in North Central Iran have been found around 6500-6000, 5700-5400, 5000-4700, 4300-4000, and 3300-2700 BCE. According to data analysis, the frequency of settlements and the trend of cultural progress gradually peaked from the early sixth millennium to the mid-fourth millennium BCE, but in the second half of the latter millennium, a gradual decline began which led to the Bronze Age collapse in ca. 2700 BCE. This event probably occurred due to the drop in temperature and the increase in the frequency and severity of aridity in the transition phase to the Late Holocene.

Keywords: : Paleoclimate, Middle Holocene, Dry event, North Central Iran, Cultural evolution.

Article Type: Research Article

Introduction

Cultural ecology, in addition to natural components and biological factors and interactions between ecosystems and living things, seeks to understand the processes of adaptation of human societies to the environment. In this process - with its theories on methods of food gathering; spatial organization; size, shape, and structure of socio-political groups; methods of reproduction; niche environment; and the attitude of societies toward the environment – cultural ecology has approaches to interpreting cultural evolution (Mosadeghi Amini and Molla Salehi 2015: 120). The study of the effects of climate events on ancient societies is not a single causal study because climate change is like a package of disasters and hazards. These events can affect the subsistence system and the health of communities. Drought-induced famine, flood-induced displacement, migration due

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to reduced environmental potential, social conflicts for access to resources, and increased mortality due to malnutrition and disease outbreaks are among the effects of climate change (Shaikh Baikloo *et al*. 2019: 11). This study - based on paleoclimate and paleo-environmental research and grounded from the perspective of the effects of Middle Holocene arid climate events on human communities - offers a different interpretation of the cultural evolution in North Central Iran during the Village Period.

According to the division of the cultural regions of Iran by Dr. Malek Shahmirzadi (1995; 2008: 34; 2017: 38-61), the cultural region called Central Plateau of Iran is the fifth one. This area presently covers the northern part of the geological zone of Central Iran. For this reason, in our publications, we refer to this region as North Central Iran (NCI). Of course, Dr. Talaei also used an almost similar term (Talaei 2008). Dr. Yousef Majidzadeh (1976; 1981) was the first Iranian archaeologist to analyze the cultural changes of this region from a historical-cultural perspective. In his doctoral dissertation, he used the term Central Plateau of Iran. This region overlaps with the two catchments of Salt Lake and the Central Desert (Dasht-e Kavir) of Iran and, in general, has a semi-arid to arid climate. The centralization of prehistoric villages in NCI can be seen in the Salt Lake basin. The existence of rivers such as Jajrud and Karaj, which originate from the Middle Alborz and have created the alluvial fan in the southern parts of this mountain range, has provided the possibility of establishing human settlements from the Neolithic to the present. In other words, the Tehran plain has been the center of cultural flourishing in the NCI region. In addition, Karaj plain, Qazvin plain, and Qomroud-Qarachay sub-basin in Qom have also been favorable areas for the formation and development of prehistoric cultures in this region during the Village Periods. However, the semi-desert and desert environment of this region has made it vulnerable to climate change, so that any fluctuation in temperature and rainfall has had serious environmental effects on water-dependent communities.

In the Early Holocene (9700-6200 BCE), with a warmer climate than the glacial but still relatively dry (Stevens *et al*. 2001: 749), the region did not have much potential for habitation. For this reason, in general, the first settlements of this cultural region, especially in the Salt Lake basin, belong to the early Middle Holocene and date back to about 6000 BCE. This study attempts to provide a high-resolution view of the Middle Holocene climatic conditions and the climatic cycles that caused dry events. These cycles have played an important role in the cultural evolutions of rural communities in NCI. In fact, this is an archaeological study from the perspective of climate change. Some climatic events appear to have put severe tensions on water-dependent communities in the vulnerable region, leading to periods of cultural decline. With this hypothesis, we intend to reconstruct the Middle Holocene climate and to correlate cultural transitions and collapses to dry events.

About four decades ago, Ahmad Tehrani Moghaddam had noticed the arid conditions of the third millennium BCE during the sedimentary stratigraphy of the Pishva Varamin cemetery (Pedrami 1985: 34-35, Figure. 10). After him, Mir Abedin Kaboli (1999: 140-142) found evidence of several paleo-floods related to the fourth to the first millennia BCE in the environmental sedimentology of Qara Tepe of Qomroud. The oldest one among those paleo-floods had probably caused the abandonment of that site. Dr. Saman Heidari Gouran (2002: 107, Figure. 3) in secondary excavations at Sialk of Kashan ("reconsideration project"), based on sedimentological evidence, revealed a dried seasonal river that possibly flowed during the settlement at the site. The drying up of this river probably played an effective role in the abandonment of Southern Sialk. Besides, the transition from Northern to Southern Sialk was characterized by a climatic shift from wet to arid conditions (Kavousifar 2004: 132-136). Dr. Ahmad Chaychi Amirkhiz (2007: 44) also dug several sedimentological pits in Mafin Abad of Islamshahr, which illustrated evidence of a paleo-flood associated with the collapse of this site (Shaikh Baikloo *et al.* 2020a: 156; Chaychi Amirkhiz and Shaikh Baikloo, 2020: 75, Table 1). According to the environmental sedimentology of prehistoric sites in Sagz Abad, located in the Haji Arab alluvial fan of the Qazvin plain, Dr. Hassan Fazeli Nashli found that the collapse of Tepe Ghabristan in the early third millennium BCE may have occurred during a climate change event. He attributed the cultural gap between Tepe Ghabristan

and Tepe Sagz Abad to unfavorable environmental conditions as well (Schmidt *et al*. 2011: 593). High-resolution paleoclimate research in Gol-e Zard Cave in Damavand also confirms the repetition of dry events during the third millennium BCE (Carolin *et al.* 2019: 70, Figure. 4). These studies generally show a climate shift to arid conditions in the late fourth millennium BCE, which peaked in the third millennium BCE and led to the cultural decline of NCI.

Methodology

The present study intends to explain the cultural evolution in NCI in relation to climatic events. In fact, it was carried out with the approach of environmental archaeology or cultural ecology. Given that climate change is the most important factor in every environmental change, it is necessary to reconstruct the past climate. To this purpose, the results of paleoclimate researches on the Holocene in the Near East have been used to reconstruct the climate of the NCI region. The latter researches have been carried out with different resolutions, but here the emphasis is on high-resolution paleoclimate research. Due to the influence of the North Atlantic climate on the climate of Iran, Greenland and the North Atlantic studies have been also used. The presented diagrams are the output of Grapher software. The analysis of the frequency and distribution of prehistoric sites in different cultural periods is based on published archaeological information. Maps by ArcGIS software and charts have been produced by Excel software. In this study, only surveyed and excavated sites with an absolute dating and a reliable relative chronology are taken into account.

Middle Holocene climatic cycles

Gerard Bond *et al*. (1997; 2001), based on North Atlantic research, identified Holocene climatic cycles due to reduced solar activity that occurred approximately every ~1500 years. These cycles have led to the occurrence of cooling events, which have been usually accompanied by an increase in aridity. The so-called Bond events occurred at around 500, 1400, 2800, 4200, 5900, 8200, 9400, 10300, and 11100 BP. The evidence of these events has been also observed in paleoclimate proxy records of Iran (Sharifi *et al*., 2015; Hamzeh *et al.,* 2017; Safaierad et al., 2020). Almost simultaneously, paleoclimate research on the Greenland ice sheet indicated nearly similar results (Cuffey and Clow, 1997; Alley *et al.,* 1997; Johnsen *et al.*, 2001), identifying warming and cooling periods of the Holocene (Figure. 1).

The Middle Holocene paleoclimate research has identified several climate changes. These events are called 8.2, 5.2 and 4.2 ka BP (Staubwasser and Weiss, 2006; Shaikh Baikloo 2020). The cultural and social impacts of these dry events have been examined in archaeological studies of Southwest Asia and other regions (Weiss *et al.* 1993; DeMenocal 2001; Staubwasser *et al.* 2003; Weninger *et al*. 2006; Shaikh Baikloo *et al.* 2020b). Apart from the already mentioned events, other climate changes have also taken place. High-resolution paleoclimate research of Soreq Cave located in the eastern Mediterranean indicates several severe dry events that occurred at 4650–4600, 4250–4180, 3700–3600, 3250–3170, and 2200–2050 BCE. Besides, climatic wet events occurred at 4700–4680, 4550–4450, 4170–4100, 3760–3740, 3500–3450, and 2800–2700 BCE (Bar-Matthews and Ayalon 2011: 169). Due to the fact that Iran's rainfall is mainly influenced by the Mediterranean climate, the results of this study can be useful in the reconstruction of the climate of Iran.

Climatic events have occurred mainly in connection with solar activity oscillations. Iranian climate and environment, especially in NCI, which has been highly sensitive to any oscillation, has been constantly stressed by climate variabilities. Medium to high-resolution paleoclimate proxy records has recorded many climate and environmental changes in Iran. Lake Neor research, located in Ardabil, with an average resolution of 3.5 years is the most accurate paleoclimate research in Iran, which covers more than 13000 years. In this study, several dry climatic events can be observed during the Middle Holocene: 6300-5900, 5600-5400, 5000-4900, 4200-3000, and 2250-1950 BCE (Sharifi *et al*., 2015: 222, Figure. 4). Lake Urmia research by Sharifi *et al.* (2019: 2) bears little resemblance to Lake Neor. According to this study, in the first half of the fifth millennium BCE, an arid climate prevailed in this area. As mentioned, this event is

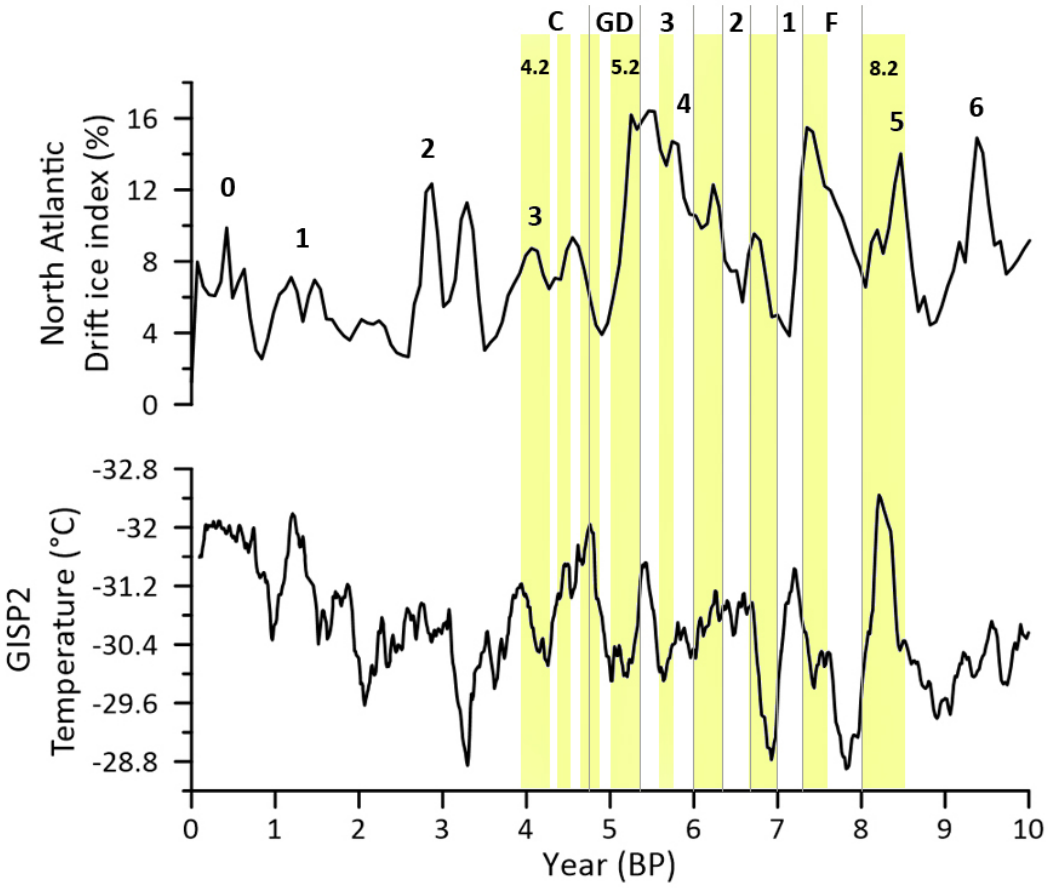


Figure. 1: *The North Atlantic Ice Drift Index based on Bond paleoclimate research (Bond et al. 2001) and temperature changes based on Greenland Ice Sheet Project 2 (Alley 2004). The numbers on the diagram represent Bond events. Yellow bars determine climatic events whose effects on the communities of North Central Iran are visible. F: Formation; GD: Gradual Decline; C: Collapse; 1, 2, and 3: Flourishing I, II, and III.*

also recorded in the Lake Neor proxy. Jazmourian Playa research with lower resolution indicates the arid climate in the 8.2 ka BP event, the mid-sixth millennium BCE, 4300, 3400, 3000, and 2500 BCE (Vaezi *et al*. 2019: 764, Figure. 8) (Figure. 2).

Humidity oscillations diagrams of Lake Mirabad in Loristan and Lake Zaribar in Kurdistan are very similar. They show the occurrence of the 8.2 ka BP event, the dry climate in the mid-sixth millennium, the decrease of humidity from the beginning of the fifth millennium, the peak of the drought in the 5.2 ka BP event, and then another decreasing wet in the mid-third millennium BCE (Stevens *et al*. 2001: 751, Figure. 4; Stevens *et al.* 2006: 497, Figure. 3). Paleoclimate research about the Katalekhor Cave in Zanjan indicates the arid climatic conditions from the 8.2 ka BP event to the mid-sixth millennium BCE. It also shows a drop in humidity in the early fifth millennium BCE. Another drop has occurred in the last quarter of this millennium. The occurrence of the 5.2 ka BP event was accompanied by a significant decrease in humidity, which can be seen up to about 2500 BCE (Andrews *et al.* 2020: 8, Figure. 6) (Figure. 2).

To summarize, the Middle Holocene (6200-2200 BCE) is divided into two parts: the early part (6200-4300 BCE) and the late part (4300-2200 BCE). In the early part, the climatic condition was mostly warm or optimal, but in the late part the frequency of cool and dry events increased. After the effects of the 8.2 ka BP event, in the mid-sixth millennium BCE, due to the decrease in solar activity, relatively

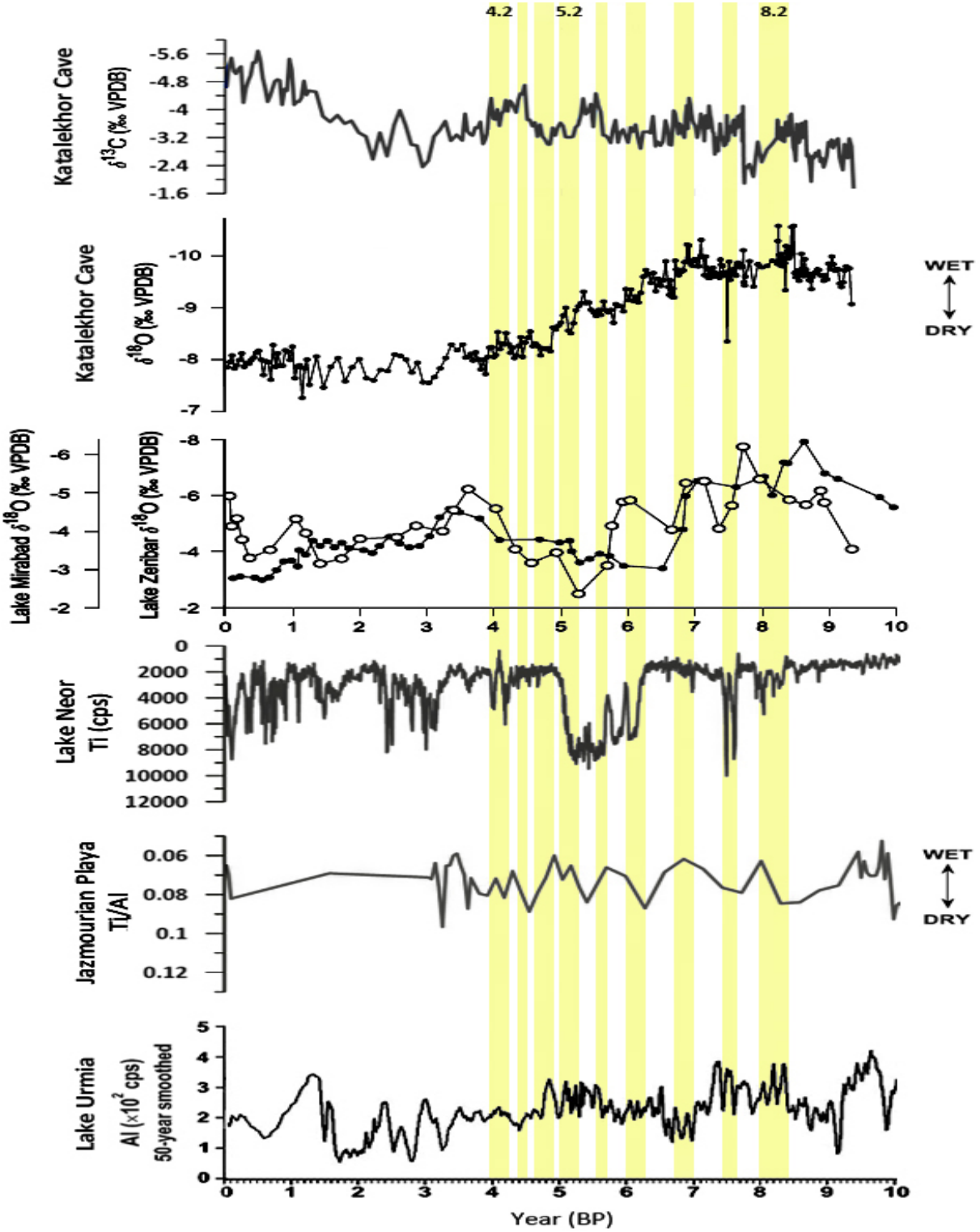


Figure. 2: *Humidity changes based on paleoclimate research of Katalekhor Cave in Zanjan (Andrews et al. 2020), Lake Zeribar in Kurdistan, black symbols (Stevens et al. 2001), Lake Mirabad in Lorestan, white symbols (Stevens et al. 2006), Lake Neor in Ardabil (Sharifi et al. 2015), Lake Urmia in NW Iran (Sharifi et al. 2019), and Jazmourian Playa in SE Iran (Vaezi et al. 2019). Yellow bars determine climatic events whose effects on the communities of North Central Iran are visible.*

dry conditions prevailed again for about 2 to 3 centuries, but after that, the humidity increased. At the end of this millennium, the arid climate re-prevailed, lasting until about 4700 BCE. Another dry event occurred around 4300 BCE (the 6.2 ka BP event) whose effects lasted until the end of the fifth millennium BCE. In the fourth millennium BCE, climatic cooling caused an increase in dry events at 3700-3600 BCE and 3300-3000 BCE. In the early third millennium a mainly cold and unstable climate prevailed. Besides, drought periods of this millennium are quite evident in the paleoclimate proxies of Gol-e Zard Cave (Carolin *et al.* 2019) (Figure. 6).

Cultural evolution in North Central Iran

The NCI cultures, after the Formation period between ca. 6000 and 5400 BCE, have experienced three periods of cultural flourishing alternatively, each of which connects to another with a climate change event. In fact, what separates these courses is a dry climatic event. Around 3300 BCE, by intensifying arid conditions, began a gradual cultural decline in NCI, which eventually led to a cultural collapse across the region in ca. 2700 BCE. During the time interval 6000-2700 BCE, the area of prehistoric villages is estimated between ca.0.5 to max. 7 hectares (Vidale *et al.* 2018: 33, Table 3).

Data concerning the archaeological sites of Tehran, Karaj, Qazvin, Qom, North Isfahan, and Semnan are presented in (Tables 1-6.)In addition, the statistical analysis graphs of data, and frequency and distribution maps of the NCI sites are also offered (Figures. 3-5). Most of these sites have been found during surveys and have not been excavated. Only the sites of Sialk, Arisman, Cheshmeh Ali, Pardis, Shizar, Sofalin, Chaharboneh, Ibrahim Abad, Zagheh, Ghabristan, Sagz Abad, Ismael Abad, Gholi Darvish, Hissar, and Sang-e Chakhmaq have radiocarbon dating (Voigt and Dyson, 1986; Fazeli, 2006; Pollard *et a*l., 2013; Nakamura, 2014; Hessari *et al.*, 2021). For more information about the sites mentioned in this article, you can refer to Shaikh Baikloo (2018: 74-212). It should be noted that the relative chronologies have been revised.

Analysis of the frequency of sites without dividing the provinces (Figure. 3) suggests that the number of sites from the Formation period to the Sialk III4-5 phase has gradually increased but then has decreased since the mid-fourth millennium BCE. The analysis including a division in provinces indicates that Semnan and North Isfahan (Kashan and Natanz) had the more favorable environmental condition for the formation of the Village Period in NCI. In each of the Qazvin and Tehran plains only one site belonging to the Early Sialk I has been found. The environmental potentials of the Qazvin plain in the Late Sialk I have made it possible to increase the number of settlements in this area. However, it seems that the Qom and Karaj plains did not have any attractiveness to settle farmer communities until the beginning of the Cheshmeh Ali cultural period.

Apparently, the Early Cheshmeh Ali period has emerged mainly in the plains of Tehran and Qom, while the frequency of sites is much lower in the semi-arid areas of Qazvin and Alborz provinces. There were probably special environmental conditions in the last quarter of the sixth BCE in this part of the Salt Lake basin. Perhaps the greater size of the lake than today has led to the concentration of settlements in these areas.

In the Late Cheshmeh Ali period, during the fifth millennium BCE (4700-4300 BCE), the number of settlements has increased throughout this cultural region, except for North Isfahan. The frequency of sites belonging to this period in different plains of NCI is close to each other. The cultural decline in North Isfahan, which began in the early fifth millennium BCE with the abandonment of Northern Sialk, lasted until about 4100 BCE.

In Sialk III1-3 and Sialk III4-5 phases, the number of settlements in Tehran, Qom and Semnan has increased. The settling in North Isfahan has also been re-formed. However, apparently, the population in the Qazvin plain has decreased significantly. It is not clear whether bio-potentials in this area have declined due to climatic events or whether foreign influxes have caused insecurity and reduced villages. It is assumed that the occurrence of the Bond 5900 BP (3900 BCE) cooling event has caused the invasion of some communities (archaeologically represented by the so-called plum pottery culture) from the northwestern regions

(Northern latitudes) to the Qazvin plain and then the Karaj plain etc. Many natives of the Qazvin and Karaj plains have probably migrated to the Tehran plain. The dramatic increase in Tehran settlements in the Sialk III4-5 could reinforce this hypothesis. It should be noted that the number of sites in North Isfahan belonging to the Sialk III1-5 is also low. In the Karaj plain, the number of sites is low, but there is no significant change compared to the previous period. Considering the location of Alborz province (the Karaj plan), it is suggested to consider the data of this area with the data of Tehran.

In the Sialk III6-7 phase, perhaps due to the end of an unspecified tension, the settlements of the plains of Qazvin and North Isfahan have increased, while the population in the plains of Karaj, Tehran, and Semnan has decreased. This marks the beginning of a gradual cultural decline. The process of reducing settlements throughout this cultural region has also continued during the Sialk IV period. Apparently, the speed of this cultural decline has been higher in the plains of Tehran, Karaj, and North Isfahan.

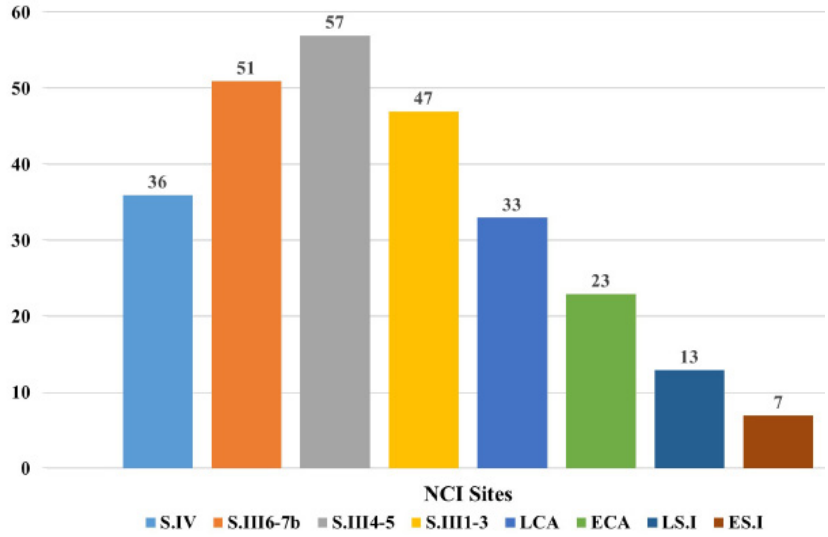
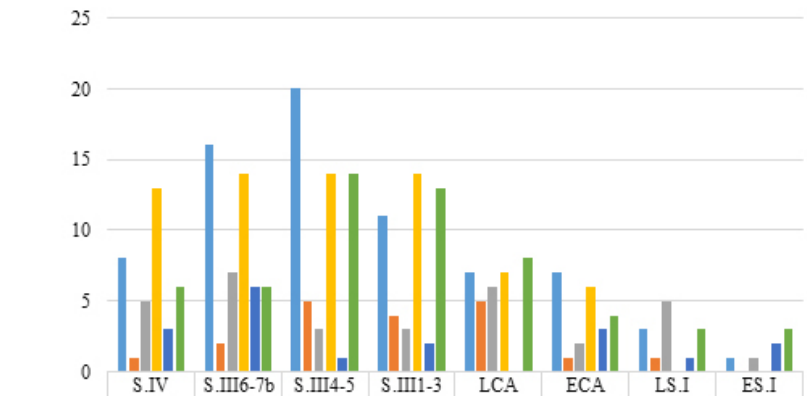


***Figure. 3**: The frequency of sites in North Central Iran in different cultural periods.*
S: Sialk; ES: Early Sialk; LS: Late Sialk; ECA: Early Cheshmeh Ali; LCA: Late Cheshmeh Ali.



	S.IV	S.III6-7b	S.III4-5	S.III1-3	LCA	ECA	LS.I	ES.I
Tehran	8	16	20	11	7	7	3	1
Karaj	1	2	5	4	5	1	1	
Ghazvin	5	7	3	3	6	2	5	1
Qom	13	14	14	14	7	6		
N Isfahan	3	6	1	2		3	1	2
Semnan	6	6	14	13	8	4	3	3

***Figure. 4:** The frequency of sites in different areas of North Central Iran from 6000 to 2700 BCE.*
S: Sialk; ES: Early Sialk; LS: Late Sialk; ECA: Early Cheshmeh Ali; LCA: Late Cheshmeh Ali.

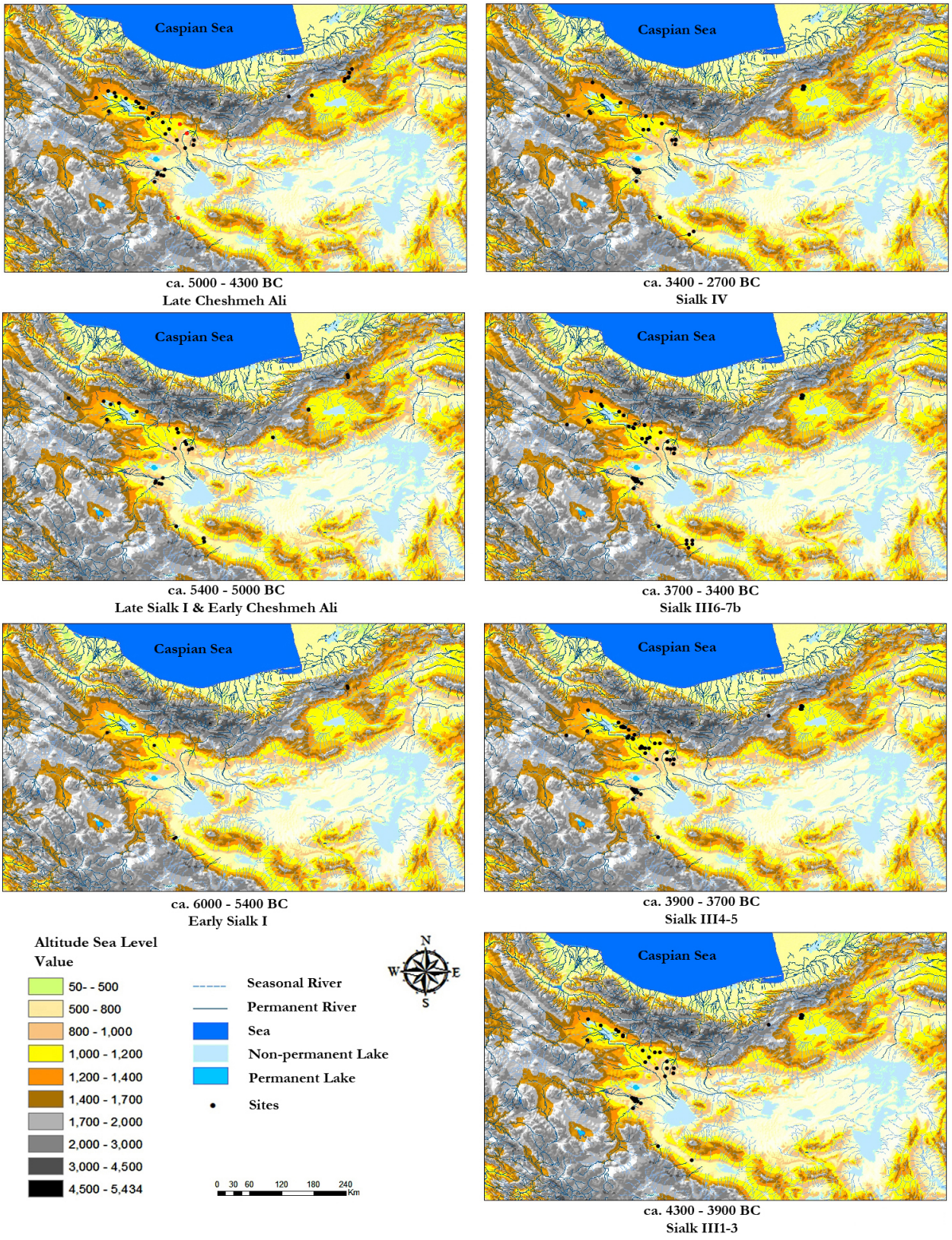


Figure 5: *Frequency and distribution of archaeological sites in North Central Iran during the Middle Holocene. Early in the Late Cheshmeh Ali period, the settlement in Tepe Pardis, Tepe Cheshmeh Ali, and Northern Sialk, which are marked with a red circle, interrupted.*

Table 1: *Tehran sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-3900	4700-4300	5200-5000	5400-5200	6000-5400	
							*	Mehran Abad
	*	*	*		*	*		Tepe Pardis
					*	*		Moien Abad
*	*	*	*		*			Cheshmeh Ali
					*			Amin Soltan
					*			Pouienak
*	*	*	*	*	*			Tepe Shoghali
*	*							Tepe Sofalin
	*	*	*	*				Mafin Abad
*	*	*						Chaltasian
*	*							Maimanat Abad
*	*							Farhangian
		*						Hesarak Lavasan
	*	*	*	*	*	*		Sadegh Abadi
			*	*				Fakhr Abad
	*	*	*	*				Mehdi Khani
	*	*	*					Ahmad Abad
		*	*					Morteza Gerd
		*						Parandak
	?	*						Gavmish Khaneh
	?	*						Tepe Arastoo
		*						Chakhmaq Tepe
		?						Heidar Abad
				?				Hosein Abad
		*						Mard Abad
	*	?						Yousef Abad
*	?	?						Dasht-e Behesht
								Kavousieh
		*	?					Kushkak
*	*	*	?	*				Zavarvar

Table 2: *Alborz sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-3900	4700-4300	5200-5000	5400-5200	6000-5400	
*	*	*	*	*	*	*		Uzbeki
	*	*	*					Gorjian
		*						Sorkhab
		*						Quheh
				*				Aq Tepe
				*				Alvand
		*	*	*				Moshelan Tepe
			*	*				Gozor Sang

Table 3: *Qazvin sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-3900	4700-4300	5200-5000	5400-5200	6000-5400	
						*	*	Chahar boneh
						*		Khaleseh
						*		Tepe Kuchar
					*	*		Ibrahim Abad
				*	*	*		Zagheh
*	*	*	*					Ghabristan
*	*	*						Shizar
				*				Khole Kuh
				*				Kamal Abad
				*				Qara Ghobad
				*				Zafran Tepe
		*	*	*				Zahir Abad
	*		*					Mansour Abad
*	*							Ismael Abad
*	*							A66
*	*							Mian Palan
	*							Sagz Abad

***Table 4**: North Isfahan sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-3900	4700-4300	5200-5000	5400-5200	6000-5400	
							*	Shourabeh
*	*	*	*		*	*	*	Sialk
*	*		*					Arisman
*	*				*			Qale Sefid
					*			Tepe Abuzar
	*							Tepe Mesi
	*							Qale Gusheh
	*							Milajerd

***Table 5:** Qom sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-39000	4700-4300	5200-5000	5400-5200	6000-5400	
	*	*	*	*	*			Qara Tepe
*				*				Gholi Darvish
	*	*	*					Shad Gholi
				*	*			10
				*	*			26
*	*	*	*					29
*	*	*	*					31
				*	*			37
				*	*			39
				*	*			42
*	*	*	*					50
*	*	*	*					51
*	*	*	*					57
*	*	*	*					58
*	*	*	*					59
*	*	*	*					60
*	*	*	*					67
*	*	*	*					69
*	*	*	*					71
*	*	*	*					72

Table 6: *Semnan sites in the Village Period between ca. 6000 and 2700 BCE*

Gradual Decline	Flourishing III		Transitional	Flourishing II	Flourishing I		Formation	Site
Sialk IV	Sialk III_{6-7b}	Sialk III_{4-5}	Sialk III_{1-3}	LCA	ECA	L Sialk I	E Sialk I	
3400-2700	3700-3400	3900-3700	4300-3900	4700-4300	5200-5000	5400-5200	6000-5400	
						*	*	East S.Chakhmaq
					*	*	*	Deh Kheir
					*	*	*	Elikaie
					*			Delazian
					*			Qumes
				*				Shirashian
				*				Gol Mohammad
				*				Khourian
				*				Siah Tepe
				*				Tel-e Khakestar
				*				Qal-eEmad alDin
				*				Pero
			*	*				Ghabristan Sar
		*						Dizaj
*	*	*	*					Tepe Hissar
*	*	*	*					002
*	*	*	*					003
*	*	*	*					027
		*	*					103
		*	*					104
		*	*					105
		*	*					106
		*	*					123
		*	*					132
		*	*					133
*	*	*	*					142
*	*	*	*					155

Discussion

Excluding the Shahroud area, located in the Central Desert basin, it can be said that in general, the formation of the Village Period in the cultural region of NCI dates back to the beginning of the Middle Holocene. According to absolute dating, Western Sang-e Chakhmaq belongs between 7200 and 6600 BCE (Nakamura 2014: 10). After a settlement gap, probably caused by the 8.2 ka BP cold and dry event (ca. 6500-6000 BCE), rural life has emerged in both basins. This climatic event occurred with a magnitude of almost half of the Younger Dryas glacial event in the Northern Hemisphere. The duration of direct stress and its effects in different regions is estimated between 160 and 600 years (Shaikh Baikloo 2020: 37). The effects of the 8.2 ka BP event in the Fars region have also been studied. The subsistence system of the communities of Fars, which was based on agriculture in the first half of

the seventh millennium BCE, changed to hunting in the second half of the same millennium and then was replaced by irrigated agriculture in the early sixth millennium BCE (Khanipoor *et al*. 2020: 64-65). It seems that during this event, the continuation of rural-farming life in some areas was practically impossible. Many societies have been probably forced to migrate towards remote regions to survive. (Weninger *et al*. 2006; 2014) have examined the dispersal of the Neolithic communities of the Levant, Anatolia, and Southeastern Europe in terms of the effects of this event.

Although the villages of NCI were formed in the early centuries of the sixth millennium BCE, it seems that an unstable climate has still prevailed until the last quarter of this millennium. Climatic proxies indicate the occurrence of arid climatic conditions in the mid-sixth millennium BCE. Perhaps, for this reason, few settlements belonging to 6000-5400 BCE have ever been discovered. In addition, probably due to the semi-sedentary lifestyle, the architectural evidence of this period is very weak. In other words, the rural-farming subsistence system has stabilized after 5400 BCE, i.e. during the Late Sialk I period. The first cultural flourishing is related to the Early Cheshmeh Ali/ Sialk II cultural period. The significant increase in settlements, the innovation of the irrigation agriculture system, and the emergence of fine and decorated pottery represent this cultural event. Evidence of Flourishing I has been found throughout the region (Fazeli *et al.* 2010; Wong *et al.,* 2010; Vidale *et al.*, 2018; Marghussian *et al*., 2021; Fazeli and Matthews, 2021).

Between 5000 and 4700 BCE, some of the most important excavated sites in this region collapsed, including Northern Sialk (around 4900 BCE), Tepe Pardis (around 4700 BCE), Cheshmeh Ali (around 4700 BCE), and Ibrahim Abad (around 5000 BCE). This is probably the case for some surveyed sites that do not have absolute dating as well. In fact, it is not clear whether sites such as Tepe Shoghali and Qara Tepe of Qomroud were inhabited without interruption from the first to the second flourishing, or whether they also experienced a cultural decline in the early fifth millennium BCE. Given the arid climatic conditions of the early fifth millennium BCE (Figure. 2), it seems that this cultural decline occurred in connection with a climate change event. Climatic and environmental influences between 5000 and 4700 BCE may have caused communities to relocate as is not visible any reduction in the number of settlements during Flourishing II. After that, flourishing has returned to this region again. This period (4700-4300 BCE) corresponds to the Late Cheshmeh Ali but its evidence has not been found in Northern Sialk and Tepe Cheshmeh Ali. In the second half of the fifth millennium BCE, the climatic conditions deteriorated again gradually, and aridity apparently reached a peak between about 4300 and 4000 BCE. The settlement in Tepe Zagheh ended completely in 4320 BCE, but almost at the same time, Tepe Ghabristan was established next to it. Radiocarbon dating shows the start of Tepe Ghabristan at 4390 BCE.

Majidzadeh (1981: 142-144) has written about the emergence of a new culture called plum pottery in this region and attributed it to the invading tribes. This culture first appeared in archaeological sites throughout the Salt Lake basin between about 4400 and 4300 BCE. Majidzadeh explains the transition of culture from Sialk II to III due to the influx of tribes with this culture and rejects the cause of climate change. However, Malek Shahmirzadi (1995; 1999: 535-537) considered this culture to be the same as Dalma. This analysis relates to a time when high-resolution paleoclimate research was not conducted. Today this arid climatic event is found in the proxy records of Southwest Asia. Therefore, if migration or invasion has occurred, it has been probably due to the environmental consequences of climate change. Also at this time, evidence of cultural interactions between the Central Zagros, Fars, and southwestern regions of Iran with NCI can be seen (Kaboli, 2015: 295-296; Nekouei and Yousefi Zoshk 2021: 235-236). This fact reinforces the hypothesis of the collapse and migration of societies due to climate pressure in the second half of the fifth millennium BCE. We call this climate change period the 6.2 ka BP event. In terms of time, this event is close to the fifth Bond event (3900 BCE).

The Sialk III culture began with the weakness caused by the 6.2 ka BP dry event but flourished from about 4000 BCE. Flourishing III in NCI lasted until about 3300 BCE, despite some known dry periods such as 3700-3600 BCE (Bar-Matthews

and Ayalon 2011: 169). Changes in the form and motifs of pottery are seen in Sialk III6-7b as well as in Sialk IV, but nothing indicates an interruption or decline of culture. The Proto-Elamite culture appeared at the late of this flourishing period and early clay tablets have been found from many sites of NCI (Hessari 2013: 15-29). This culture, which was formed in parallel with the Late Uruk culture, was able to last until the early third millennium BCE, but the Uruk culture collapsed during the 5.2 ka BP dry event (Shaikh Baikloo *et al.* 2016: 49-50). In the fourth millennium BCE, the number of sites increased. During the Chalcolithic Age, important changes such as permanent settlement, organized agriculture and animal husbandry, economic progress and development of commercial networks, specialization of techniques such as specialized production of pottery, metal, and stone tools have occurred, and generally simple Neolithic social structures to social and cultural complexities transformed (Matthews and Fazeli, 2004: 61; Nekouei and Yousefi Zoshk 2021: 242). In the late fourth millennium BCE, this region experienced some abrupt changes such as the lack of decorations and paintings on the pottery and the change of their application, the appearance of regular planning in architecture, and the use of cylindrical seals and counting tablets in Sialk IV1 (Abbasnejad and Asadi 2016: 23). In some settlements, a gap or evidence of horizontal displacement on the site between the Sialk III6-7b and the Sialk IV1 (ca. 3400-3300 BCE) has been found (Asadi and Abbasnejad 2020: 64). Further, the cultural influences of the southwestern region, similar to the Uruk trade network, are also evident in the sites of the NCI region and also throughout the Iranian plateau (Helwing 2013: 95-98).

Between ca. 3400 and 2700 BCE, the NCI region gradually declined and finally reached a complete stagnation, while having the potential to enter the Urban period. This collapse occurred most likely due to the harmful cultural and socio-economic effects of the 5.2 ka BP dry event, which has led to an unfavorable and erosive climate period. Continuation of these conditions is observed with increasing frequency and intensity of dry periods during the third millennium. The 4.2 ka BP event, which is the end time of the Middle Holocene, has degraded all civilizations and cultures of Southwest Asia and Egypt (Weiss 2017; Staubwasser *et al.* 2003; Hamdan 2016) (Figure. 6).

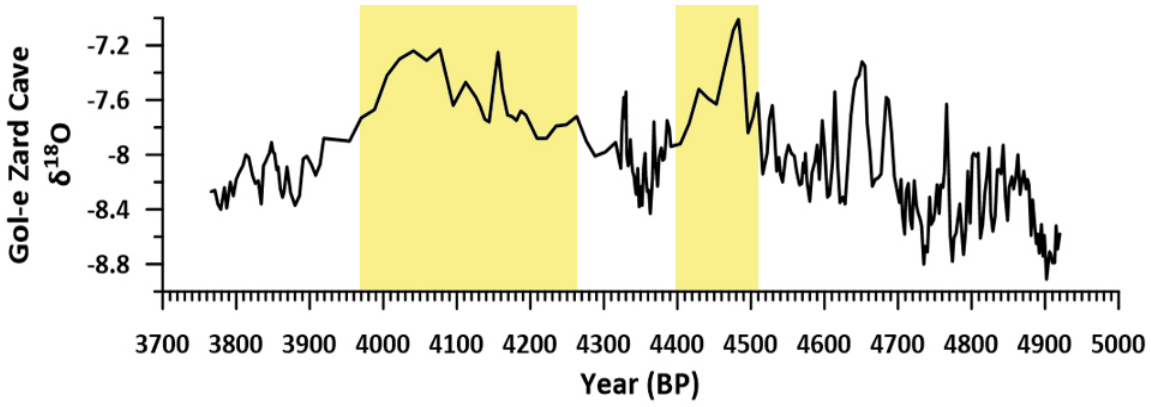


Figure 6: *Humidity change diagram based on the proxy record of Gol Zard cave in Damavand, 50 km northeast of Tehran. Yellow bars indicate dry events. This paleoclimate research in NCI shows the 4.2 ka BP event between 4260 and 3970 years BP (Carolin et al. 2019).*

Conclusion

Alluvial fans and sub-basins created by Jajrud, Karaj, Qomroud-Qarachay, and Haji Arab (Qazvin) rivers have played a major role in the distribution of Neolithic and Chalcolithic settlements in NCI. These villages, with an average area of 2 to 3 hectares (in the flourishing periods) - which indicates a low concentration of population - maintained a balance between needs and resources according to the environmental potential of the region. In fact, the idea of adaptation to conditions due to the continuation of climatic and environmental instabilities seems to have been the most prominent concern of prehistoric human societies in NCI.

Paleoclimate data suggest that most parts of NCI due to the semi-desert to desert environment and semi-arid to arid climate, up to ca. 6000 BCE, i.e. after the 8.2 ka BP cold and dry event, were not attractive for the settlement of farmer communities. During the Early Holocene, due to the situation of the Earth's orbit and tilt axis, in general, an arid climate has prevailed in the subtropical region of the Northern Hemisphere. Very cold and long winters and hot, and short summers have been characteristic of the Early Holocene. From the early Middle Holocene to about 4500 BCE, the Earth's orbit and tilt axis gradually changed to their current situation. Since then, spring rains increased and led to the spread of the Zagros forests, but at the same time, solar energy has also declined, increasing the frequency and severity of cold and dry events. The human societies of NCI from the sixth to the fourth millennium BCE went through three periods of flourishing that were connected by climatic events. Although These events caused environmental pressures, their effects were not so great as to lead to a widespread cultural collapse. However, by the late fourth millennium BCE, the deterioration of the climatic condition was unprecedented. The 5.2 ka BP dry event is confirmed by most paleoclimate proxies in Southwest Asia. Thus, the process of cultural development and population growth from the Late Neolithic to the Chalcolithic, which had peaked in Sialk III4-7b, gradually declined from about 3300 BCE and led to a widespread and prolonged collapse in North Central Iran in ca. 2700 BCE. This event probably occurred due to the drop in temperature and the increase in the frequency and severity of aridity in the transition phase to the Late Holocene. It seems that the increase in social complexity or the strong dependence of the components of society on each other during the fourth millennium BCE has accelerated this cultural collapse, because the general disturbance caused by the disruption of a component in complex social systems is much more severe and widespread than simple early systems. Such a consequence could also occur with increasing current global warming. Therefore, environmental archaeology or the study of the effects of climate change on ancient communities can also predict future perspectives.

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