The Modality of Climate Change in the Middle East: Drought or Drying up?

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Abstract

Due to its widespread political and social consequences, the relationship between drought and climate change in the Middle East has been widely reported on by the media. Climate change is mainly understood within the paradigm: “prolonged drought is created and intensified by global warming.” The purpose of the study is to review this paradigm and examine aspects of it. Thus, climate trends in the Middle East are studied across three periods: 1900–1970, 1970–2000, and 2000–2017. Due to the importance of studying sequences of drought occurrence based on timescales of climatic patterns, the climatic trends of the Khuzestan Plain, were examined too. The results show that to have a clear understanding of both the modality of climate change in the Middle East and the current dominant paradigm, predominant assumptions of the paradigm should be reconsidered. For example, prolonged droughts are part of the natural pattern of climate in the Middle East, although the current drought has not been recorded for at least 100 years. This claim is based on the fact that prolonged droughts in this region can have natural causes, which can be studied as long-term climate trends, although the impact of global warming on the escalation of the Middle Eastern drought is undeniable. However, the exacerbating effect of non-anthropogenic factors on the impact of drought in the region should be studied, too. Additionally, as an epistemological assumption, the term “drying up” (as a new normal and permanent climatic pattern) should be used instead of “drought” (as a normal and reversible pattern) to determine the current climate change situation in the Middle East. The author concludes that the findings emphasize the need for further research in order to identify the modality of climate change in the Middle East.
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Keywords

Climate change – drought – drying up – Middle East and North Africa (MENA)

1 Introduction

In common with other geographical phenomena, the correct description of the modality of climate fluctuations largely depends on its scale. In this paper, climate fluctuations in the Middle East are discussed with a focus on different aspects and durations of drought. Typically, when a climatic phenomenon extends beyond a specific geographical area or a specific period, it can be recognized and classified as a distinct phenomenon known as “prolonged drought” (Al-Ansari 2013; Chenoweth and Hadjinicolaou 2011; Hoerling et al. 2012; Huttner 2014; IPCC 2014; Kelley et al. 2015; Sowers and Weinthal 2010; Terink et al. 2013; Voss et al. 2013; Wang 2005; World Meteorological Organization 2013). However, this raises certain questions: for how long should the current drought have to continue in order to be considered a drought, which is a normal climate event, as opposed to a feature of climate change? Does a particular length of time determine the differences between short-term, long-term, and irreversible droughts? According to which criteria are climatic conditions with “less than normal precipitation” classified as climate fluctuations, and according to which criteria are they considered as representing “climate change”? For various reasons, dryland ecosystems are rather fragile (Colin et al. 2015). Desertification and degradation are pervasive in drylands, and therefore it is vital to predict the nature of future climate trends.

To plan for coping with the impacts of irregular precipitation in the Middle East, it is very important to identify the nature and magnitude of such precipitation. Depending on the scale and severity of this phenomenon, the type of planning to manage its effects varies. It can include various “mitigation” or “adaptation” projects. Often, such projects can be difficult and costly to run and even require changes to the lifestyles of local people. However, in the Middle East, adaptation to even severe droughts is part of the culture and way of life (Kelley et al. 2015). Therefore, if the dominant media paradigm presents severe droughts as merely normal, it can be assumed that local communities will find it harder to accept changes to adapt to their effects. Thus, it is essential for decision-makers and local populations to understand the modality of climatic trends in the Middle East. In an environmental
management system, mitigation and adaptation are distinct economic and technical domains. In the comprehensive policymaking systems of countries in the region, the current abnormal situation in the Middle East has so far been considered an environmental and agricultural problem but the impacts of this phenomenon have resulted in widespread political, economic, and social instability as well (Elasha 2010). Moreover, many international institutions have emphasized that continued drought might have played a significant role in the spread of violence and international terrorism in the Middle East (Al-Maanari et al. 2017; AMGEN 2013; Chenoweth and Hadjinicolaou 2011).

The primary hypothesis of my research is: the current climate timescale in MENA is not compatible with the normal definition of drought. In this regard, while pointing to the epistemological aspects of the main paradigm of this debate, such as drought, climate fluctuation, climate change, drought, and climate extremes, I also discuss in detail the quantitative components related to the timescales of this phenomenon. Additionally, in this paper I examine the likelihood of whether the current situation will continue or discontinue. In this respect, in addition to examining previous trends (from the early 20th century to date), I consider possible future trends in climate change for a 100-year period, up to the year 2100.

My analysis is an initial effort to address three questions: (1) what are the relative contributions of drought and global warming in the Middle East, and to what extent can global warming trends be used to predict future climate trends in the Middle East? (2) To what extent is the current drought in the Middle East consistent with the long-term climate patterns in the region? And (3), if the current climate conditions in the Middle East are accepted as a new normal, how can this normality be best defined?

2 Concepts and Study Area

Of the various ways in which climate change inflicts harm, drought is the cause of most concern (Pew Research Center 2015). However, it is important to note that there is a lack of clarity on how the impact of climate change causes drought (Al-Maamary et al. 2017).

Drought is one of the most complex concepts in physical geography. In contrast to other extreme events, such as floods, which are typically easy to pinpoint in space, droughts are not restricted to small regions but affect wide areas (Zamani et al. 2015). It is difficult to provide a precise definition of drought
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(Trenberth et al. 2007; Donald et al. 1985) report 150 different definitions of drought. The Fourth Assessment Report of the Intergovernmental Panel of Climate Change (IPCC) states: “in general terms, drought is a ‘prolonged absence or marked deficiency of precipitation’, a ‘deficiency of precipitation that results in water shortage for some activity or for some group’ or a ‘period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance’” (IPCC 2014, x).

Agricultural drought relates to moisture deficits in the upper meter of soil (i.e. the root zone) impacting crops, meteorological drought is mainly a prolonged deficit of precipitation, and hydrologic drought is related to below-normal streamflow, lake levels, and groundwater levels. The differences in the aforementioned types of drought reflect the relative roles of precipitation, evapotranspiration (ET), and runoff in drought caused by climatic factors. Water availability is also a societal and environmental concern, and includes factors such as the demand for water. Hence, there are other possible definitions of drought that relate to water scarcity. A special report on climate change by the IPCC includes a paper with a valuable discussion of drought or “dryness,” drought drivers, and drought indices (Seneviratne and Nichols 2012). Drought can be quantified and described in absolute measures (such as soil moisture levels or lake levels) or relative measures, e.g. various versions of the Palmer Drought Severity Index (PDSI), one of which can be accessed via the US Government’s drought portal, www.drought.gov, and both types of measures can be compared. Because drought is defined by one tail of the probability distribution function of a drought measure, such as soil moisture content or streamflow, a small reduction in the mean, e.g. -5 per cent, will translate into a much larger increase in drought frequency based on other drought definitions. Consequently, this difference has caused some confusion regarding the magnitude of drought changes. The use of the percentiles of soil moisture or streamflow instead of mean values to define drought and its changes may represent a better approach.

In most academic definitions, drought is considered “a period of less than normal precipitation for a specified period” (Donald et al. 1985). Talaksen and van Lanen (2004) also emphasize that drought is ascribed to conditions with less than normal precipitation in “an annual volume of precipitation.” The question of how much less-than-normal precipitation may indicate a drought is challenging. A 30-year period is considered adequate for determining climate average (Alijani Bohlool 2016). Hence, if a region has had less-than-normal precipitation or more-than-normal temperature or evaporation continuously for more than 30 years, the eventuality of climate
change in that region and the emergence of a new normal climate will be considered. What can be said about current climatic conditions in the Middle East?

With an average annual precipitation of 166 mm, the Middle East is the world’s driest region (Huang et al. 2016). Throughout history, 18 countries in the region, ranging from Iran in southwest Asia to Egypt in northeast Africa, have more or less always faced drought (Sowers and Weinthal 2010), although, according to historical evidence, the average precipitation amounts were higher in past centuries and millennia than they are today (Sharifi et al. 2015). The historical development of the Middle East was very affected by frequent periods of alternating dry and wet years, which was not only reflected in lifestyles, but was also one of the most important political and cultural factors in shaping the social structure of the region.

A review of the historical data confirmed extreme and alternating periods of drought (e.g., Kelly et al. 2015). However, interestingly, the region was once wetter than it is today. For example, the average annual precipitation on the Persian Plateau circa 6,000 to 5,500 years ago is estimated to have been four or five times more than the current average (Moradi Ghiasabadi 2005). In ancient times, the historical civilizations living on the Iranian Plateau and in Mesopotamia, East Mediterranean, and North Africa all faced the same challenges. Civilizations such as the Achaemenid, Elamite, Sumerians, Akkadian, Phoenician, and Carthaginian had an important role in human achievements at the dawn of history (Karami 2016). All evidence suggests that those civilizations emerged in a fertile geographical context, in contrast to the current situation (Sharifi et al. 2015).

The assumption that climate change and particularly frequent and long-term droughts were one of the causes of civilizational collapse has been much discussed. In the classic Sumerian texts (3500 BC), the original homeland of the Sumerian ethnic group was Dilmun, which evidently was located in southwest Iran (Bahar 1997), where the provinces of Fars, Khuzestan, and Bushehr are located today. According to the Sumerian texts, Dilmun was a lost paradise—a beautiful, green, and fertile land (Moradi Ghiasabadi 2005). However, today, the three provinces have a very different appearance from that described by the Sumerians. Sharifi et al. (2015) have shown the main climate trends in southwest Asia during the last 5000 years (Figure 1). As shown in Figure 1, this region has always faced frequent periods of drought and wet years. However, the gradual fall of the ancient civilizations in the region was associated with long periods of drought, which have since gradually become more intense and longer in duration.
The vertical orange bands shows periods that were dry and dusty. The transition between ruling dynasties (grey arrows) in Iran and North Mesopotamia coincided with the change in climate (reproduced from Sharifi et al. 2015, 229, with permission of Arash Sharifi).

3 Climate Trends in the Middle East

In most countries in the Middle East, meteorological data has been carefully documented and studied from the early 20th century onwards. For example,
these trends have been registered by two official sources—the IPCC (2014) and the World Meteorological Organization (2013)—and analyzed by Kelley et al. (2015). From these sources, it is evident that there have been three general trends in the region, corresponding to the periods 1900–1970, 1970–2000, and 2000–2017.

First, since the records of climate data began between 1900 to 1970, temperatures have risen and there has been a decline in precipitation throughout the Middle East, although the variation between trends is often less than 20 per cent. This period is considered a “normal” climate.

In the period 1971–2000, temperatures rose and the reduction in precipitation was more or less continuous in the region (IPCC 2014). Although the trend in precipitation reduction and temperature rise in the first half of the 20th century was more noticeable in the Mediterranean than in other areas, the trend in precipitation reduction and temperature rise was more noticeable in the Mediterranean than other areas, and was more pronounced from the 1970s onwards (World Meteorological Organization 2013).

Analyses of the climate trends in the Middle East in the period 1970–2000 have focused on two areas: (1) the Sahel Desert and (2) the Atlas mountain region including the northern part of Algeria and Tunisia. In the Sahel Desert region, the 1970s and 1980s saw the most intensive periods of drought (El Raey 2010). In this regard, increasing numbers of dry days (less than one millimeter of rainfall per day) have been noted in the coastal strip of North Africa (Elasha 2010), as well as continued less-than-normal precipitation in the Atlas Mountains and the northern parts of Algeria and Tunisia (Sowers and Weinthal 2010). This trend has also been observed in the westernmost part of Morocco and East Africa, particularly in the Horn of Africa (Hamid 2009). Continued drought in the past 30–60 years in northeast Africa has led to landscape changes and diminished natural regeneration. The trend for Mesopotamia has been more or less similar. Iraq and Syria are the most prominent countries in the Middle East in which the new climate trends have occurred (Kelley et al. 2015). One recent NASA study revealed that the drought that has been affecting the Levant region in the Eastern Mediterranean since 1998 is probably the most intense of the past 900 years (Cook et al. 2016). Observations and model calculations confirm that heat extremes have become more frequent in recent decades, while the number of cool days and nights has decreased. For example, the numbers of warm days and nights has almost doubled since the 1970s (Lelieveld et al. 2016).

Possibly the most political recorded climate change in the history in the Middle East and North Africa (MENA) region has occurred in the period 2000–2017. There have been repeated claims that prolonged drought is one of the causes of the political changes that have been called the “Arab Spring” (Al-Maamary et al. 2017; Carrington 2015; Colin et al. 2015; Kelley et al. 2015; Abed 2015).
Since 2002, the region has received less-than-normal precipitation and temperatures have risen. The drought peaked in the years between 2006 and 2009 (Al-Ansari 2013), when, for example, Syria and Iraq received ten per cent less precipitation than normal (Chenoweth and Hadjinicolaou 2011). Following the drought, large parts of the agricultural system and livestock were lost, and 50 per cent of the irrigated land and 80 per cent of the rain-fed cultivated land was abandoned (Huttner 2014). In this area, a three-year drought is not unprecedented and normally does not lead to landscape changes. In the winter of 2006–2007, Syria and the greater Fertile Crescent, where agriculture and animal herding began some 12,000 years ago, the worst three-year drought, according to instrumental recordings (R. M. Trigo et al. 2010) was experienced. The climate change impact on the region was clearly apparent in the increase of ambient temperature by circa 4 °C more than the average in the 1960s, accompanied by a severe decrease in precipitation (Carrington 2015). In this regard, also Cook et al. (2015) have emphasized that instrumental observations have shown that the Mediterranean region has been becoming dryer since the 1970s.

With regard to predicted climate trends in the Middle East up to the end of 2100, Figure 2 shows precipitation predictions for the MENA region, based on IPCC findings (IPCC 2014), considering the continuation of global warming. The rate of reduction in precipitation and average temperature rise are shown in both optimistic and pessimistic scenarios. Evidence also indicates that many landscapes in the region have rapidly dried up: it is predicted that the Tigris and Euphrates—the two historic rivers to which Mesopotamian history and civilization in large areas of Syria and Iraq were linked—will have completely dried by 2040 (United Nations 2010).

Yet another study has indicated that the future precipitation trend in northwest Iraq (a desert region with typically a southeastern Mediterranean climate) and the future precipitation trend in northeast Iraq (a mountainous region with climatic conditions typical of western Iran) will lead to a reduction in precipitation and drier climates in the coming decades, suggesting both optimistic and pessimistic scenarios (Al-Ansari et al. 2014).

On average, the maximum temperature during the hottest days in recent years in the Middle East has been circa 43 °C, and this could increase to circa 46 °C by the middle of the century and reach almost 50 °C by the end of the century, according to the IPCC’s RCP8.5 (business-as-usual) scenario (Lelieveld et al. 2016). Even if climate change in the 21st century will be limited to a global mean temperature increase of 2 °C relative to pre-industrial times, warming over land will typically be higher than over the oceans, and extreme temperatures in many regions may increase well above 2 °C (Seneviratne et al. 2016).
The Paris Agreement aims to limit global mean surface warming to less than 2 °C relative to pre-industrial levels (UN 2015). However, the above-mentioned statistics suggest that this target is only realistic for humid lands, yet drylands, as well the whole of the Middle East, will have greater risks of warming. In short, in the 21st century, a warming of 3.2–4.0 °C over drylands and 2.4–2.6 °C over humid lands could occur when global warming reaches 2.0 °C, thus indicating ~44 per cent more warming over drylands than humid lands (Huang et al. 2017).

4 Causes of Current Long-Term Drought in the Middle East

As mentioned in the introduction, the dominant hypothesis for explaining the causes of the Middle East drought is the global warming paradigm. According to this paradigm, long-term drought in the region will mainly be caused by global warming, and due to the inevitability of at least a 2 °C rise in global temperature, it is expected that the Middle East and North Africa will become warmer and drier by the end of the 21st century (IPCC 2014).

A commonly held notion is that increased evaporative demand in a warmer world will enhance drought (e.g., Dai 2016), but it is important to understand where precipitation or evaporation changes will be dominant individual drivers
of drought and where they will work in concert to intensify drought (Taylor et al. 2012). However, some studies have indicated that there might also be non-anthropogenic reasons for drought in the Middle East. For example, Cook et al. (2014, 2015, 2016) claim that the recent drying trend has been variously attributed to a mixture of natural climate variability and anthropogenically forced change. Some researchers have noted the possibility of macroclimatic components such as ENSO (El Niño–Southern Oscillation), SAM (Southern Annular Mode), IOD (Indian Ocean Dipole), and NAO (North Atlantic Oscillation), as well as the displacement of the subtropical high-pressure belt (Golmohammadian and Pishvaei 2014). Based on the Palmer Index, Wang (2005) indicates that in the 20th century, hyper-arid areas (including countries in the Middle East countries) increased by 22 per cent, and were mainly affected by ENSO that occurred in the 1980s. However, the correlation between the 1980s ENSO and global warming has not yet been proved.

One author has suggested that compared with the results of the World Climate Research Programme’s CMIP3 (Phase 3 of the Coupled Model Intercomparison Project) and NAO, the Indian Ocean may have a larger role in changing the climate in the southern and Eastern Mediterranean regions to a drier one (Hoerling 2012). NAO can affect large parts of the Mediterranean and the Red Sea, and enclose low-pressure systems over Iceland in the northern latitudes, which usually leads to drought in those places (Karami 2016). According to Jalili et al. (2012), intensification of NAO since the early 1980s might be one of the causes of drought in the Middle East and North Africa. There are some indications that drought in the Middle East is related to a subtropical high-pressure belt (Golmohammadian and Pishvaei 2014). Several studies have addressed the climate trend to the north of subtropical high-pressure cells in the cold months, which constitute a climate anomaly and are considered the cause of drought in the Middle East and southern Mediterranean. Due to natural causes, multiyear droughts occur periodically in the Fertile Crescent, but it is unlikely that the recent drought would have been as extreme, given the century-long drying trend (Colin et al. 2015). Global warming is expected to increase the frequency and intensity of droughts in the 21st century, but the relative contributions of changes in moisture supply (precipitation) and evaporative demand (potential evapotranspiration, PET) have not been comprehensively assessed (Cook et al. 2014).

According to research conducted by Trigo et al. (2000), reduced precipitation in the wet season in the Mediterranean since the early 1960s has been due to weakening cyclones in the Mediterranean region. This climate condition is thought to be related to atmosphere–ocean interactions in the North Atlantic (Cook et al. 2015). Jalili et al. (2012) argues that the Azores High, which is the most important system for precipitation rates in the Middle East, has changed.
since the early 1960s. With reference to several studies, Terink et al. (2013) suggest that the changes in surface variables may be related to the behavior of large-scale circulations, such as ENSO, which is the most common source of episodic droughts worldwide (Neelin et al. 2003). Hence, it is probably not possible to determine reliable decadal and longer-term trends in drought due to climate change without first accounting for the effects of ENSO and the Pacific Decadal Oscillation (Neelin et al. 2003).

As noted above, the impacts of macrocomponents on climate in the Middle East have been attributed to global warming by some researchers, but there is no conclusive evidence to prove this hypothesis. Looking at prolonged drought periods in the region during the past millennium, non-anthropogenic components can be considered a more serious cause of the current drought in the Middle East. The role of other anthropogenic factors in global warming, such as the anthropogenic factors in climate change, are not yet important for the location and timing of droughts. However, when droughts do occur, it is expected that the extra heat from global warming will increase the rate of drying, leading more quickly to droughts that are of greater intensity (Chou et al. 2009). Since the uncertainties are much greater than the exact findings we have at our disposal, we should talk about them more cautiously.

5 Case Study: The Khuzestan Plain

The climate of the Khuzestan Plain (Figure 3) is representative of the typical climate in the Middle East, due to its specific location between the Zagros
Figure 4  Khuzestan Plain, Iran, and selected synoptic stations (source: http://data.mapmart.com/htmlpages/map.html).
Mountains (the largest mountain range of Middle East), the Persian Gulf, and the deserts in Iraq and the Arabian Peninsula (Figure 4). The plain is dominated by three main types of climate systems in the Middle East: the warm and dry climate resulting from subtropical high pressure (especially in warm season); the Mediterranean humid climate (mainly in winter); and some mainly warm and humid currents that originate from the Indian Ocean. Accordingly, data from four synoptic weather stations were reviewed as typical for climate trends in the Middle East. The four stations were: Abadan—a port in the Persian Gulf and in the south of the plain (mainly warm and humid climate); Ahvaz in center of the plain (mainly warm and dry, widely affected by the heat waves from Iraq and the Arabian desert; Ramhormoz in the east of the plain (partly mountainous, moderate weather in winter); and Dezful in the north (warm and dry).

6 Data and Methods

The meteorological data from the four weather stations was sourced from the Meteorological Organization of Khuzestan Province. Initially, I investigated the statistical trends in the thermal indices, the absolute maximum and absolute minimum temperatures, and the average annual precipitation. The trend models were analyzed using Minitab software, and various models were used to verify the obtained trends. Eventually, I determined that a quadratic model represented the lowest error criterion and therefore selected it as the most suitable one. Finally, the output of the model was presented in the form of simplified, informative graphs. Figures 5–8 show the climate trends at the four weather stations in the period 1961–2015, from which the following points can be deduced:

– The annual average of temperature significantly increased at all four stations.
– The average temperature rise was circa 1.5 °C at all four stations.
– The temperature rise (to the highest temperature) mainly occurred in the warm season, when the region was mostly affected by subtropical high pressure. However, this needs to be investigated further and supported by documentary evidence.
– After the 1980s, the precipitation gradually declined. However, in earlier periods (the early 1960s to early 1980s) the precipitation was higher than normal.
– In general, it appears that the trend in average temperature rise was more pronounced than the trend in precipitation reduction.
– The trend in annual temperature rise continued throughout the period 1961–2015, and the trend in precipitation reduction lasted circa 35 years.
**Figure 5** Trend Analysis plots for Abadan, 1961–2015: lowest temperature (top left); average temperature (top right); highest temperature (bottom left); precipitation (bottom right).

**Figure 6** Trend Analysis plots for Ahvaz, 1961–2015: lowest temperature (top left); average temperature (top right); highest temperature (bottom left); precipitation (bottom right).
Figure 7  Trend Analysis plots for Dezful, 1961–2015: lowest temperature (top left); average temperature (top right); highest temperature (bottom left); precipitation (bottom right).

Figure 8  Trend Analysis plots for Ramhormoz, 1961–2015: lowest temperature (top left); average temperature (top right); highest temperature (bottom left); precipitation (bottom right).
These results mainly support the findings of earlier studies. For instance, a study of the changing streamflow in the Karkheh river has shown that in the southern part of the river basin of this river (in the southern part of Khuzestan Province) the availability of freshwater will on average decrease by 44 per cent (Zamani et al. 2015). A separate study found that the discharge in the rivers Karkheh, Karun, and Marun decreased by 49, 37, and 40 per cent respectively in the period 2000–2001 compared to the average in the preceding 32 years (Zamani et al. 2017). Also, Vaghefi et al. (2014) have emphasized that estimates of future climate data indicate an increase in the frequency of dry periods, and in the extreme south of the Khuzestan Province, increases of up to 201 days are predicted.

7 Discussion

Evidence suggests that the global warming trend in the Middle East is occurring at a rate one-and-a-half times faster than the global warming average (Al-Maamary et al. 2017; Colin et al. 2015; Droogers et al. 2012; Verner 2012). In recent decades, the climate in the Middle East has become warmer and drier, and temperatures have increased circa 3 to 4 per cent each decade (Al-Ansari et al. 2014; AMCEN 2013; Huang et al. 2016). Elasha (2010) has predicted that the precipitation average in the Middle East will decrease by circa 20 per cent and the temperature will increase by circa 3 to 5 °C. According to Milly et al. (2005), the runoff in the Middle East will decrease by circa 20 to 30 per cent by the end of the 21st century. The above-mentioned predictions are supported by various researchers, including Al-Bayati (2011), Christensen et al. (2007), and Droogers et al. (2012).

The following assumptions can be made about climate trends in the Middle East:

- There was a surge in temperatures throughout the entire region during the period 1960–2017.
- There was an increase in warm days and a decrease in the numbers of cold days and nights throughout the region during the period 1960–2003 (Al-Zawad and Aksakal 2010).
- The climate models suggest a marked increase in the average summer temperature in the region due to human activity that affected the environment, and with the increasing frequency of high temperatures in summer, the cold temperatures have become less frequent in the same season (Avnery et al. 2011; Iglesias and Rosenzweig 2009).
– Since the beginning of the 20th century and around the year 1900, when meteorological recording began, the trends have continued, more or less, and towards a drier region. At the same time, the first half of the 20th century can be considered as having had normal drought and the second half as having had severe drought.

– There is a relative correlation between drought intensification in the Middle East and global warming intensification (Amiraslani and Dragovich 2011; Chou et al. 2009; Hoerling et al. 2012).

– The 1970s, 1990s, and 2000 can be regarded as a period of transition from normal drought to severe drought, which led to severe water stress in affected countries in the region such as Iran, Syria, and Iraq (Kelley et al. 2015; Trenberth et al. 2014).

– There is some evidence to suggest that parts of the Middle East are experiencing prolonged drought, and there have been some changes in the macroclimate patterns of the region (Karami 2015).

– According to the most optimistic scenario (i.e., that the drought in the Middle East is just anthropogenic, and subsequent control of the global program to reduce greenhouse emissions may reduce it), the perception still exists that to some extent the drought is irreversible (Richey et al. 2015; Voss et al. 2013).

– Specifically, there is a strong tendency for dry regions such as the Middle East to become drier following a poleward expansion of the subtropical dry zones (Seager et al. 2010).

8 Conclusions

Long-term drought in MENA has created a new climatic and environmental condition that is quite different from the normal climate in the Middle East. However, some hypotheses suggest that this new situation is not abnormal but should rather be considered as a new normality. These include assumptions about the long-term persistence of this phenomenon, uncertainty about the change in it, whether it has stopped, whether it is reversible, and its similarity to Paleoclimatic trends in the Middle East, which often made the region warmer and drier in the past millennium (Cook et al. 2016).

However, if it is assumed that the drought is not temporary, that it probably will continue for at least several decades, and that some of its effects are (and will be) irreversible (particularly the possibility of permanent hydrological drought in some areas of the region), it is doubtful whether the term “drought” is appropriate. Future studies could investigate whether what has occurred in
the Middle East could be termed “drying up” as a new normality of permanently drier and warmer land has replaced the old one. Due to this epistemological aspect in the study of climate change in the Middle East, this assumption (i.e., drying up rather than drought) is important in its normative implications in that it could change the nature of the governance structure and development targets and policies.

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