Factors of climate extremes hyperactivity: a study on MENA

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It is hard to say that all climate events are entirely related to global warming. In this regard, models usually used for global warming predictions are not appropriate for some of climate trends. For instance, prolonged drought in MENA region could not be analyses by global warming predictions. It seems the climate condition in this region is better understood by using the new concept “climate hyperactivity” rather than using the usual global warming predictions. Drought in MENA region is different with other precipitation and temperature rates throughout the world. On one hand, MENA drought is not nonlinear and is not a sudden climate change. On the other hand, there is no sign of reversibility or temporality of climate change in MENA; therefore it is not a macro-climate change either. In fact, MENA drought is a type of hyperactivity of normal behavior of climate factors which leads to a new normal climate in the region. According to Paleo-climate studies, in previous millennia, some kinds of similar climate hyperactivity has led the region to a drier and hotter climate. Rather than focusing on epistemology of climate change, this article compares MENA’s drought with the dominant paradigm of climate change which is concentrated on global warming and greenhouse effect. According to climate factors, the region’s climate change is more effected by natural and climate factors than greenhouse effects.

Keywords: Climate Hyperactivity, MENA drought, prolonged drought, climate change, Middle East, Khuzestan

INTRODUCTION

The climatology is mainly a science of climate predictions. Prediction is not only the main purpose of climatology but a very challenging issue. Statistical trends, which are applied for traditional climate predictions, are not reliable as before. Nowadays it's said that in climatology the past is not the light for the future (Hargreaves and Annan, 2009). Statistical trends are mainly applicable for short stage scales, because some of complicated measurable components such as solar radiation deviation or macro climatic extremes oscillation (i.e. NAO and ENSO) may completely change the whole trend. In addition, in recent decades, the anthropogenic factors -such as widespread GHG and greenhouse gas emission- has changed the global climate and forced to re-modelling the statistical trends. Today, different components are used to predict normal climate trends. In this regard, historical trends as well as anthropogenic components are also applied for climate predictions. Annual IPCC climate predictions are developed by using three groups of basic data:

1- Statistical meteorological trends (with 100-200 years of historical background);
2- Co2 and greenhouse gas emission rising;
3- Changes in main components of climate system (i.e. temperature), because of Co2 and greenhouse gas emissions rising.

In recent years, the widespread worrying and media concern about global warming has made the IPCC predictions...
and its modelling methods more applicable. Meanwhile, according to a review of economic, social, geographical and environmental analytic reports of climate change, a large number of them are basically developed in reference to IPCC prediction models (i.e. NASA reports). IPCC reports are very important. So, such questions should be asked:

- Are IPCC statistic prediction trends reliable?
- Do they have any weaknesses?
- Is there a more adequate alternative to predict climate change?

IPCC has always tried to reduce the potential errors by re-tuning data (IPCC, 2014) which is a necessary technic to improve IPCC models. It is a weak point. In this regard, the problem is not the model but inputs (IPCC, 2012). In order to develop accurate prediction trends and model tuning, inputs must also be controlled, which is a second problem.

Majority of current climate models are based on statistic trends and are more mechanical and less climatological. These basically are developed according to permanent physical and meteorological data (i.e. solar radiation, temperature, precipitation, GHG emissions and the like). Researchers couldn’t include the impacts of macro climate phenomenon such as periodical solar radiation, extreme oscillations such as ENSO and NAO and ongoing earth's axis deviation in these models and despite the development of many new technologies, the climate predictions are not accurate enough.

MENA region is an example that current models and definitions on climate change are not applicable enough. In this region, the climate change is no longer a concern of the future, but a crisis of everyday lives and the climate trends are neither similar to those of the 20th century nor do they correspond with IPCC reports (The World Bank Middle East department, 2010).

Reviewing the history of climate events suggests that the region has historically been facing droughts so many times (Mwangi et al. 2014). But prolonged, intensity and widespread droughts in the region in recent decades -from West Africa to Southwest Asia- is unlike to any of the past historical droughts (FAO 2008). Furthermore, this drought is not corresponding with any of IPCC scenarios (Stimson 2013). Considering the continuity, the vast intensity and its potential irreversible effects, MENA drought can in fact be a drying up not just a drought.

According to these points, these questions should be considered:

- Regarding MENA drought, why is its duration and intensity different with other common climate trends in the region?

- If, as many scientific models suggest, MENA drought is irreversible, then why it is called “drought” and not “drying up”?

Drought is a short-term and temporary period of abnormal low precipitation (Karami 1999). Meanwhile due to vulnerability of ecosystems in MENA, climate predictions are a key prerequisite for survival. Prolonged droughts have struck most countries of the region for about forty years in the past (Omar et al. 2013). Undoubtedly, part of mismanagement of water resources, inaction or late reaction towards water resources wasting is mostly because of unawareness of the duration, intensity, and the extent of drought in the Middle East. Because of no accurate conceptual understanding of the phenomenon, a proper reaction was not done, although supportive documents and climatological statistics have always been accessible for everybody -especially for the governors and policy-makers.

Neither the government nor locals have not serious reaction to the terrible condition (Sowers et al 2010). It’s often considered a normal climate fluctuation and it’s assumed that if the climate returns to wet periods, the droughts’ negative impacts will disappear as it frequently happened in recent 100 years. So, instead of adaptation with the new condition, all are waiting the climate returns to the previous status. This kind of ignorance of climate change, alongside mismanagement of water resources consumption has converted the climatic drought into an agricultural and hydrological drought. In fact a climatological phenomenon has converted into a geomorphological one. Long-term impacts of prolonged drought in the Middle East is visible from the Mid 70s onwards (Dai 2011) but it is always assumed a temporary condition.

In recent decades a widespread and extensive Geo-engineering was implemented throughout the region (manipulating land’s hydrologic system by damming, digging deep wells, etc). Such policies increased the human’s water consumption to the expense of nature’s portion decrease. For instance in Iran, almost 90 percent of precipitation is wasted by human before flowing on the ground or feeding the underground aquifers (Karami N, 2015).

This process threatens the natural life. In addition, there are two important points: 1) low environmental standards in the region; 2) composing the region mostly with deserts and vast salt marshes which sustaining their ecologic capacity is not the local governments’ priority. These two factors led to ignorance of long-term impacts of drought in the region.

At the beginning of the twenty first century, the scientific institutional attention was drawn to the water resources decrease; just when it effected on drinking water amount and made the agriculture vulnerable.
In Iran, during the last recent 30 years, 70 percent of renewable water is consumed (Karami A. 2015), and each year, the underwater level is going down 80 cm. In February 2015, The Ministry of Energy formally announced that the agriculture is prohibited in half of the Iranian plains. The Environment Department also announced that 70 percent of Iranian ponds completely dried up. Advisor to Iran’s president also stated if the condition continues, much of the Iranian Plateau will be uninhabitable in forthcoming three decades. (Karami N. 2015).

Also, because of late reaction towards drying up impacts, the opportunity to rescue many of natural landscapes is lost. (Elliott Brown 2015). To rescue the rest, there is no way but applying a tough project: "National Austerity Program". Although, regarding the water resources, Iran’s accessibility to water resources is much better than other Middle East countries.

In North Africa and particularly the west borders of the Red Sea, political, economic and social infrastructures have gone under tremendous destruction (Medany 2009). In recent decade, a climatic political change, the Arab Spring, which led to regime collapse in Egypt and Tunisia, made the prolonged drought to reach into its peak. Many researchers claim that these series of political changes are influenced by the climate change (Genesis 2013).

After Arab Spring there is a widespread effort in academic and scientific sphere to represent a newer and more practical understanding of the climate change in MENA (Femia and Werrell 2012). It’s a sign of the ignorance of MENA nature’s tolerance threshold which first led to conversing a natural phenomenon to an anthropogenic and then to a political one. According to these arguments, the 2009-2011 Drought in the MENA region put the climate change an issue to the politics.

According to the results of fourteen climate prediction models (which later increased to 23 cases) NASA claims that in the forthcoming years, the climate change will basically change the precipitation regime and its distribution all over the world. This means that the precipitation will decrease in the areas besides the tropical latitudes, but will increase in tropical and Equatorial latitudes.

The main consequence of this condition is desertification and increasing dry years in current dried areas, increasing tropical storms and more intensive floodwaters in Equatorial latitudes. According to this report, recent drought in MENA isn’t a normal climatic fluctuation, but can be consider as a unique, unprecedented and permanent conditions.

It seems that before the NASA reports about the anomaly of World Precipitation (Hansen 2013), it was assumed that the climate change is just a high latitudes’ problematic.

Although this research is a different discussion, it is discussed that the climate issues related to high latitudes’ climate change (i.e. Polar Ice melting and Rising ocean) doesn’t have significant and direct impact on low latitude countries, especially in the Middle East. We will later discuss on validity of NASA reports and its coordination with the current climatic condition in the Middle East, but with no doubt the NASA report contributed a vital role in changing the attitudes towards the long-term drought in the Middle East.

However the report is prepared in the same way as applied by IPCC; it is a mathematical model which predicts the extent of climatic fluctuations in the future by studying the impacts of global warming (temperature increasing under the influence the greenhouse effect) according to normal statistical trends.

In this paper, by reviewing the Middle East drought dimensions, the causes of this drought and the factors impacting on its continuity and intensity is discussed. The main purpose of this research is to introduce a model describing the climate trends in MENA by comparing the dominant paradigms in climatology with prolonged drought in the Middle East and highlighting the differences. The ultimate purpose of this research is comparing the climate change factors in MENA with ordinary models of climate prediction models. At the end, we will try to introduce a new conceptual framework appropriate for the particular condition of climate change in the Middle East.

**Concepts and Methods**

How to determine the intensity, duration and extent of the climate trends is the main challenging issue to explain and analyses them. In Geography, such factors are named "scales". In this regard, "climate fluctuation" is assigned to a temporary and periodically condition and is reversible, but if the trend changes to a non-reversible condition, the new situation is named “climate change” which may be caused by natural factors as well as anthropogenic ones.

The most important challenging issue of current climate change is the climate change caused by global warming (because of fossil fuel consumption and co2 emission). Since it is returnable, the current climate change is treated as “anthropogenic climate change”. However, there are scientific disagreements about this argument as well as epistemological debates.

Regarding IPCC’s 2014 report, and even in the most pessimistic reports it’s scientifically confirmed that the globe was hotter than now for many times (despite warming up the earth Till 2100, and increase of the average temperature of the Earth up to 5.7°C) (Maslyn 2009). Also many documents confirm that the Earth has...
always been much cooler than now, we should note that the current situation is a feverish period that even without co2 emission might be hotter than the previous historical periods (Lawton et al 2003).

So, other Ice ages in the future are likely possible! The climate change theory advocates do not deny the impacts of future ice ages on cooling the Earth but they insist that the future of man and our historical period which our generation is living in is also important (Lovelock 1995). Even if a new ice age in distant future is possible, but by the end of this century, the world is going to get warmer at least 3 centigrades; even if the average co2 emission caused by fossil fuels doesn’t increase anymore (It means that co2 emission arising from the industrial growth in the countries such as China, India, etc. is not considered and calculated). In this regard, at least 7 meters of polar ice will melt, the seas will rise for about 0/74 meters and 20 percent of globe’s inhabitants will be displaced (Prudhomme et al 2014).

The main epistemological disagreement is right here. When the contemporary period is the basis to analyses the climate trends, then every long change in climate components as well as any change in the average normal factors may be called “climate change”. In this regard, the climate is what we have created according to normal life style (Nicholls et al 2012). So, there are short, medium and long periods of climate change according to different periods of normal temperature changes (i.e. 30, 100, 300, 1000-years period according to the statistic trends in middle (latitudes).

The climate change theorists strongly believe in anthropogenic aspect of it. They confirm that natural factors cause these periodical fluctuations, but they insist that the climate change is mainly caused by global warming and is absolutely an anthropogenic phenomenon. The scientists have explored that co2 emission increase significantly correlates with “the extent of Polar ice melting” and “the increase in running water in areas such as Greenland” (IPCC 2014).

Now there is a question: Is there a direct relationship between co2 emission and climate trends in other parts of the world also? How does anthropogenic factors contribute in current global warming, and how does the normal change in temperature occurs?

The influence of natural factors such as ENSO or The North Atlantic Oscillation (NAO) and Indian Ocean Dipole (IOD) has always been highlighted as important factors to explain the global temperature increase (Anderson 2012). The contribution of each of this phenomenon in changing the normal climate components should be highlighted. For instance, in the last IPCC report has declared that the co2 emission is the direct cause of increasing the Earth’s average temperature for 0.75 percent (IPCC 2014) (From the beginning of industrial revolution which the greenhouse effect increased because of using fossil fuels). Besides, from 1975 onwards the frequency of EL-Nino has increased from 1 in 7 years to 1 in 2 years. However, the scientists suppose that ENSO has started 4000-5000 years ago and there is no evidence to confirm that it has occurred before that time (Maslin 2009).

Whenever El-Nino happens, the Globe gets warmer for one centigrade. So, if we accept the IPCC assumption that the Earth has got 0.75 degrees warmer in recent forty years, we may also assume it’s mostly because of El-Nino and is not an anthropogenic phenomenon caused by greenhouse effect.

It is logically hard correlating the increased El Niño frequency from mid-70s onwards with co2 emission increasing from the beginning of the 21st century. Even it is impossible to explain why ENSO suddenly occurred 4000-5000 years ago. It is also impossible to predict the possibility or extent of El-Nino for a 6-months period (Moric et al 2012). According to a research, at least 25 percent of current global warming is because of increased solar radiation (Donohoe, et al 2014). If we collect the sum of warming caused by solar radiation with the sum of warming caused by El-Nino then no portion is left for co2.

Actually as said before, lack of scientific knowledge to predict the climate trends and guess which components impact on climate trends is not the main problem. But the necessity to predict the complex components to adapt the climate change according to its ecologic abilities is the main issue. So, according to mega climate trends, what is called climate change may be called climate fluctuations. A review of climate change experts’ and climatologists’ debates show that many of them don’t ignore global warming, but they criticize some of its epistemological dimensions as well as the mechanical and mathematic-based models of famous institutions such as IPCC.

In this paper just one aspect of the conceptual challenge of climatology especially climate change is discussed. Therefore, the climate trends in MENA in recent one hundred years are studied in two periods: 1- recent forty years and 2- recent ten years. In these two periods the widespread drought in the region started and then intensified. Most of the related statistics are extracted through the formal reports.

The aim of this review is considerable from two points of view: First, to understand the statistical climate trends and second, to understand how these trends head into the prolonged drought. Then, these trends will be compared with the assumptions of drought detection in the Middle East. The next step is studying the dominant theoretical paradigm which is “the impact of global warming on prolonged drought in MENA.” As the last step these factors have also been studied: Impacts of mega climate events such as ENSO, NAO, SAM, IOD and other less recognized ones such as Cosmo-
climatological on global warming. The anthropogenic effects, but unrelated to CO2 emission is also discussed. But as said before, the main purpose of this research is not classifying the reasons for prolonged drought occurrence, but is to introduce a new interpretation of climate change in MENA and challenging the existing dominant paradigm which declares the climate change happens just because of anthropogenic factor - the greenhouse effect.

**DISCUSSION**

The Middle East and North Africa (MENA) covers an extensive region, extending from Morocco to Iran, including all Middle Eastern and Maghreb countries. The term is roughly synonymous with the term the Greater Middle East. Presents an extensive area limited by Iranian Plateau in the west-south of Asia to Morocco in the Atlantic Coast. MENA normally includes Eastern edge of Iranian Plateau, Eastern Mediterranean countries, Northern edge of South of Caspian Sea, Arabian Peninsula and Horn of Africa, Southern edge of countries on the North of Africa Sahara, Morocco and Mauritania the West of Africa and Atlantic Coast. (Fig 1). In some references, like this research, The Horn of Africa is part of MENA also. There are some shared cultural, historical, religious and also climate components which make the MENA a shared landscape with strong correlation in spatial and local aspects.

MENA is intensively affected by the high pressure of tropical latitude (Gaemi et al 2008) which makes the region’s climate strongly hot, dried and mid-dried except some highlands. In some parts of MENA the average precipitation is more than the average global one. For instance, in South-West coast of Caspian Sea the average annually precipitation is around 1200 mm (Karami 2009). But in much of MENA the average annually precipitation is 250 mm, less than one third of the average global precipitation. In some extensive areas such as Lute desert, Dasht-e-Kavir in Iran, Rub’ al Khali in Saudi Arabia and Sahara Desert, the average precipitation is less than 100 mm. The temperature is also a function of latitude and the altitude of the area. In highlands in Iran and Turkey, the temperature goes down the -25°C in January, but in some areas such as Red Sea Coast, the temperature doesn’t decrease less than the 25°C even in the January. In Low-lying areas in the Middle East, which includes a large area of MENA, the maximum temperature in July is usually more than 45°C. The maximum formally recorded temperature in the Earth is 58 centigrades in Ben Aziz Sahara in Libya and the informal recorded temperature is 63 in July in Kavir-e-Lut, Iran (Karami 2009).

MENA's historical background is attached to the Great Rivers such as Nile, Tigris, Euphrates, and Karun. The World’s most important centers of ancient civilizations were shaped besides the Rivers. The water supply has always been a challenging issue in the Middle East. This has led to develop saving methods and invent complex techniques to control the running water, extraction, transferring water, and water share in the region. Some methods such as aquifer management, Qanat (Aqueduct) construction or particular methods to irrigation alluvial in Egypt are rooted in the history for thousands of years. According to Paleo-climatological data the climate has always been against MENA. The historical evidences implicate that between 2000-4000 years ago the Middle East climate was more moderate and more humid. This
circumstance has led to form the most ancient civilizations in Iran such as Carthage and Phoenicia in North of Africa, Sumer and Akkad in Mesopotamia and Achaemenid Empire in Iran. But the trends have always made the region’s climate drier.

There are some evidences confirming that from 2000 years onwards, the Isotherm 21°(the proper temperature facilitating to form the civilization and development) has gradually moved from Middle East to the high latitudes (Shakooee 1995). According to archaeological studies, between 2000 to 3000 years ago, the most important civilizations established in the south of Iran. in Sistan, Fars and Khuzestan region. In middle ages, these areas stagnated and the central part of Iran flourished; such as Kerman, Yazd and Isfahan. In the contemporary era, the luckiness of the central region of Iran is descended and political, economic, and cultural welfare is given to the Northern area of the country (Karami N, 2015). This condition is also visible, more or less, in other parts of MENA. For instance, Hunt et al (2007) in their study “An 8000-year history of landscape, climate, and copper exploitation in the Middle East” claim: Investigations of geomorphology, geo-archaeology, pollen, palynofacies, and charcoal indicate the comparative scales and significance of paleo-environmental changes throughout the Holocene at the junction between the hyper-arid hot Wadi’Arabah desert and the front of the Mediterranean-belt Mountains of Edom in southern Jordan through a series of climatic changes and episodes of intense mining and smelting of copper ores. Alleviation during early Holocene followed the impact of Neolithic grazers but climate drove fluvial geomorphic change in the Late Holocene, with a major arid episode corresponding chronologically with the ‘Little Ice Age’ causing widespread alleviation. Wood harvesting for charcoal may have been sufficiently intense and widespread and may have effect on the capacity and intensity of tree species to respond to a period of greater precipitation deduced for the Roman Byzantine period a property that affects both taphonomic and biogeographical bases for the interpretation of palynological evidence from arid-lands with substantial industrial histories. In this regard, figure 2 shows generalized form of climatic fluctuations in Near East since about 7000 years ago. (Riehl et al 2014).

In recent decades, huge oil revenues made MENA an arena to develop mega projects in water industry. Aswan dam in Egypt, Nahr-Al-Sanaee in Libya, the greatest Desalination project in Saudi Arabia, and mass damming in Iran and Turkey are just a few examples. Today a large number of ecologists and environmentalists do criticize many of these projects, because much of water usage policies in the Middle East are ambitious and they haven’t environmental assessment (Sowers and Weinthal, 2010). Another critical problem is the population growth and high demand for water consumption. Although before the prolonged drought starts, water wasting beyond its capacity has made the meteorological drought to be ready to convert into hydrologic drought (Seager et al 2010).

**Climate Trends**

The drought in the MENA region began in 1970s. Since the region had always experienced periods of drought, normality and wet years, it was widely believed that the current prolonged drought is an ordinary climate oscillation which will be substituted by normal and abnormal periods (Arab water council, 2014). In the past ten years, as the drought continued and intensified, climatologists gradually came to assert that the current MENA drought is unlike all the previous droughts which were recorded in the last one hundred years in the
region. Obviously, the intensity of the drought varies across the region. For instance, regarding the westernmost point of the region, in West Africa, the climate change occurred nearly two decades earlier than IPCC predictions and more intensive than the average climate change in the world (Hoerling et al. 2011). Morocco can be considered one of the victims of irreversible droughts. In the early 20th century, the country is facing drought every ten years and currently it faces 5-6 droughts every ten years (IPCC 2012).

According to climate observations, precipitation is continuously decreasing in the south of the Mediterranean and the Saharan region (Elasha 2010). The figure 3 shows the climate trends is decreasing regularly and continuously (IPCC 2014). However, the percentage decrease of climate trends intensified in 1970s. The 70s and 80s mark the most severe drought periods in Saharan region, throughout the region, particularly in the north and the south (El Raey 2010). The reports also indicate that from early 1970s, the precipitation in the northern coast of North Africa, including the Atlas Mountains and the Mediterranean shores of Algeria and Tunisia, decreased tremendously (Sowers 2010). According to the same observations, the number of dry days (less than 1 mm of rainfall daily) in the region has reached 330 days per year (Elasha 2010).

Meanwhile, over the last 60 years, precipitation rates have gradually decreased in the Horn of Africa in the seasonal summer (June-September). This is due to the pressure changes at sea level and the gradient between Sudan and the south coast of the Mediterranean (IPCC 2014). There are frequent and evident reports which confirm this phenomenon. For instance, severe climate changes, such as droughts and heavy rainfalls, have frequently occurred in East Africa in the past 30 to 60 years. The combined effects of low precipitation and temperature rise in East Africa have resulted in prolonged droughts in the region for recent 30 years. Today, East Africa is an example of a region with tremendous destruction caused by climate change. What is said to be a future catastrophe in industrial countries and Northern Europe (climate change in the form of melting polar ice caps and rising sea levels and etc.) are real everyday’s catastrophes in East Africa (AbdelRaouf, 2009).

According to four separate researches, the temperature growth rate in Africa is faster than global average increase during the 21st century (Christensen et al., 2007; Joshi et al., 2011; Sanderson et al., 2011; James and Washington, 2013). Elasha (2010) indicates that during two decades, the temperature has increased about 2°C in Ethiopia, throughout the country and in all seasons. The extensiveness of this temperature rise indicates that it may spread to the neighboring countries (which usually lack similar climate statistics and information). Furthermore, the point that temperature rise is visible during the year and not in a particular season is the indicative of its impact on intensifying and spreading the consequences such as evaporation, hydrologic drought, etc.

According to climate statistic records, the recent 30-years period of drought in this region could be the most effective and the longest drought. This condition is repeated in all parts of MENA region. In this regard the warming trend started 60 years ago and intensified from 30 years onwards (Arnell 2011). The precipitation pattern
is also changed. Besides the intense droughts, the severe floodwaters occurred in the East of Africa in the past 30-60 years. It means that precipitation had little impact on feeding the water resources. Instead, it led to intensifying the soil erosion and environment destruction (Elasha 2010).

Regarding the climate change, we don't need to wait for a long time to understand the catastrophe which will occur in 2050 or 2100. It is visible in Syria in the most painful form. It's about forty years that Syria is facing with drought. But what occurred 2006 to 2009 practically led to destruction of much of agricultural and livestock infrastructures. In rural areas, thousands of people lost their jobs and moved to the cities, the cities with no chance or opportunities to welcoming them (Huttner 2014).

In Syria, drought has abandoned about half of irrigated agricultural lands and almost 80 percent of dry farming lands. Most of ranchers either have sold their livestock with very low price or lost them. What has led Syria to this condition is an average 10 percent decrease in precipitation and 10°C increase in temperature.

In Iraq, the severe drought has started in 2007. Before starting this period, the land under cultivation consisted 9 percent of the country's area. But the agricultural land decreased 4 percentages in 2009. These trends are indicative of the continuity and intensification of the drought.

The figure 4 shows the estimation of water reduction in the basins of Euphrates and Tigris Rivers between 2000 and 2025. In these two regions, life is strongly dependent on agriculture. Neighbouring Iraq, in Kuwait, the studies also indicate the climate change. From 1975 onwards, the country was warmer almost 1.5-2°C, both earlier and more intensive than the average global temperature rise.

The Figure 5 shows the precipitation statistics of the last 60 years in Iran. According to formal reports of Meteorological Organization and Ministry of Power of Islamic Republic of Iran, the precipitation rate significantly decreased 18.8 percent. The Figure 6 shows the temperature changes at the same period in Iran which indicates that Iran got warmer 1.1 °C.

The figure 7 also indicates that the volumetric flow rate of Karkheh River, the longest river in Iran decreased. But according to project manager of the national project of the climate change in Iranian Environmental Protection Agency, the average temperature increase rate in Iran
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was 1.5-2°C and until 2030 it may also increase to 4°C. From mid 90s onwards, much of the area was exposed to hydrological drying up.

The drying up is so severe that it is repeatedly said that one of the oldest civilizations of the world is going to collapse (Brown 2015). According to presidential adviser, half of the population of Iran will be forced to migrate in the next thirty years (Kalantari 2015). In some analytic reviews, it’s claimed that Iran is in the process of Somalization; because the process of drying up the country is devouring all economic and social infrastructures (Karami 2014).

Regarding the overall analysis of the climate change trend in MENA, there is an important point: The frequency of drought period in MENA is now 5-6 cases in ten years, instead of one case in 10 years. According to FAO report it’s also expected that the average precipitation rate in The Near East and East of Mediterranean will decrease 10-30 percent. Most studies show that in North Africa the temperature increases much faster than normal global trend.

At least we can say that the warming in MENA occurred two times faster than the global warming trend. The figure 8 presents a general view of precipitation and temperature
temperature variations in Africa by using different climate models (IPCC 2014). But as mentioned before, it seems that the IPCC reports represent a conservative image of climate change trends in the Middle East. In Table 1, which is prepared on IPCC formal reports, the climate trends in the Middle East temperature are presented on the basis of optimistic and pessimistic scenarios for three periods of 2030, 2070 and 2100.

In this regard, we see that what has occurred in the Middle East is much worse than the most pessimistic IPCC scenario which will probably occur in 2030. So, the climate trend in the Middle East is closer to the scenario of 2070, than that of 2030. We can also claim that in some countries (i.e. Syria, Iraq and Iran) what is predicted that will occur in 2050, happened in 2015.

Figures 9, 10, 11, 12, 13, and 14 show the precipitation and temperature trends of 3 places in Khuzestan Plain. These places have different Geographical situations in hillsides of Zagros, North of Persian Gulf, and deserts between Iran and Iraq. As we can see, statistical models shows the trends of reduction in precipitation and increase of temperature which have continued throughout the past 60 years, will continue.
HYPOTHESIS (HYPERACTIVE CLIMATE FACTORS IN MENA)

Global warming

Some researches claim that prolonged drought in MENA is part of global warming trend. One of the most reliable researches is a shared research done by University of California, Irvine and NASA’s Goddard Space Flight Center. This research used 14 statistical models, which later increased to 23 models. According to this research, the global warming will result in some kind of anomaly in earth’s precipitation. It means that the rainfall in current dried areas such as MENA region will decrease, but will...
Table 1. IPCC’s scenario about trends of temperature in MENA. (Adapted from IPCC report 2007. By: Elasha 2010).

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<tr>
<th>Years</th>
<th>Best scenario</th>
<th>Worst scenario</th>
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<td>2030</td>
<td>0.5 – 1.5</td>
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<td>2070</td>
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<td>2100</td>
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rise in tropical raining areas (Hansen 2013). The result will be: non-returnable drought in MENA, intensifying the desertification, and intensifying the process of converting meteorological drought into agricultural drought. Despite the researchers just pointed a quick hint to the causes behind these trends, but it seems they believed that the only cause of such events is global warming.

Periodical Climatic fluctuations

It’s a long time that MENA is categorised as a dried zone. Numerous researches suggest that the extensive drought periods always were repeated in the region, even more intensive than the current situation, but the current drought is different. For instance, drying the rivers and lakes which have always had flowing body of water in recent Millennia are a few signs of severe drought in the region. Some of paleo-climatology studies indicate more intensive drought periods in different regions in MENA, but there is no document of such a widespread intensive and pervasive drought, at least in written documents.

EL-Nino Southern Oscillation (ENSO)

In low latitudes, what is supposed to be climate change is the effect of ENSO. (Yeh et al 2009). According to climatic observations, 1950 and 2010 the frequency of drought occurrence coincides with the trends of ENSO intensification and El-Nino occurrence frequencies. As an extreme conclusion, we may relate the intensive drought in MENA to ENSO. There are some clear evidences which
which suggest that in 80s the increasing of dried areas in the twentieth century, which is about 22 percent (according to palmer Index) was caused by ENSO (Wang 2014).

According to another research, west of Indian Ocean and East of Red Sea are two main origins of precipitation in the Middle East which is strongly affected by ENSO. It is also observed in Iran, which is a mass part of east of the Middle East, the humidity is in the maximum level when the two mentioned climate origins in Indian Ocean and Red Sea are maximized and the strong Indian summer monsoon occurs (Keshavarz 2012). In the period of the study, the maximum of annual temperature changes is correspondent with strong Indian Monsoon and the maximum of annual domain changes is also correspondent with strong La Niña.

**Climate change in Indian Ocean, IOD and SAM**

According to numerous researches, including the works of Ghaemi 2003 and Barlow et al 2001 Indian climate change is a cause of drought in Mediterranean arena and MENA. Hoerling (2011) suggests that the results of the research he has done with his colleagues, show that the Indian Ocean impact is more than CMIP3 and even NAO on Mediterranean drying up.

**North Atlantic Oscillation (NAO)**

NAO effects on making deep blocks in Mediterranean and Red Sea and blocking the Iceland Low in high latitudes which potentially causes drought. Therefore, the NAO intensification in recent three decades (Golmohammadian and Pishvaei 2014) could be suggested as one of the causes of MENA drought.

**Displacement of the subtropical high pressure belt**

The most important component which causes the climate fluctuations is the subtropical high pressure belt displacement, especially two important cells which effect on the climate of this zone: The High North Atlantic and The High Indian Ocean. Anomaly in the normal displacement of the subtropical high pressure belt (in the direction of high latitudes, around 38°North Latitude in the summer, and in the direction of low latitudes, around 14° South Latitude in winters) may lead to frequent wet and dry periods in the Middle East. (Ghaemi, 2003).

Active high pressure in high latitudes in winter makes dry and warm winter. Because the precipitation mainly occurs in this season, so the winter subtropical high pressure anomaly directly means a dried and a low rainfall year. According to Terigo and Davies study (2000) reduced precipitation in wet season in Mediterranean in recent four decades is because of severe weakening of Mediterranean cyclones which is related to atmosphere-ocean interactions in the North Atlantic.

According several researches, the most effective system on precipitation in the Middle East named “The Azores High”, changed its behavior in recent fifty years. Jillian (2007) discussed that the intensified and strong days of “The Azores High” were much more than weak days in second half century and it tended to exacerbate and increase. A similar research between 1960-2002 also showed a strong correlation between annual fluctuation range of subtropical high pressure belt in the East Mediterranean and the frequency of cyclones of Central East Mediterranean. The impact of these fluctuations on precipitation in west and north-west of Iran is significant (Mohammad Nezhad et al. 2010). Actually, any of these researches doesn’t specify the impact of displacement of subtropical high pressure in climate change in MENA. A focused research should be done to figure it out. It seems it is one of the main components of climate change in the region. But this hypothesis needs more and detailed verifications.

**Domino effect**

The climate is an interactive phenomenon. On one hand, there is strong synergistic interaction between climate and geomorphic factors and on the other hand, in internal climate factors. If one component is changed, the other components may change also, which finally leads to the climate change. So, because of Domino effect of climate factors, sometimes events are further than trends. Statistical trends are calculated according to specified components, such as temperature or precipitation, while other factors do change the whole behavior of the climate cycle. Sometimes it is not practically possible to find the first component which made the Domino started. Even it might not be a critical component.

So, to analyze The Global Climate Change is not easy, even in a limited scale like MENA drought. Depending on research method and available documents, each climatologist assigns the main role to a different component, even if the main scenario and the main component which mainly changed the system behavior is unknown. In MENA, many factors significantly changed. So, the main question is which one started first and stimulated other factors. Understanding the Domino behavior certainly my lead us to a better understanding of climate hyperactivity and to understand why all the factors suddenly were led to a more extreme and faster consequences than normal behavior.

**Increased solar radiation**

Some researchers suggest small change in the solar radiation in that past 100 years. Therefore, IPCC rejects...
the impact of the solar radiation fluctuation in global warming. However, as mentioned before, Nicholls et al and James et al claim that at least 25 percent of current global warming is because of fluctuations in solar radiation. (Maslyn 2009).

**Anthropogenic factors (except global warming)**

The causes of landscape changing factors and final output of prolonged drought -i.e. biologic, probably un-returnable collapse and drying of the land- should be separated. Poor management of water resources (which is common in the Middle East in the form of unsustainable agriculture) is converting the meteorological drought into the hydrologic, economic or social drought. In this regard a climatic phenomenon changed into a geomorphologic one. In Iran, more than 90 percent of water resources are wasted through unsustainable development programs such as damming (which is two times more than ecologic standard), unsustainable agriculture, etc. So, the land is getting dried and the effects of climatic drought are getting more extreme or un-returnable. Nevertheless, there is doubt about the human role as a main factor of drought (reduced precipitation compared to normal status).

**CONCLUSIONS**

To study the prolonged drought in MENA on the basis of global climate change theory is not an accurate analysis. Despite all uncertainties, obscurities, and several hard and mostly unanswered questions, the climate change in MENA is worse than all scenarios we have observed even in the most pessimistic reports prepared based on regular global warming trends. Regarding some evidences, the climatic trends usually change the landscape in a very short period and beyond the human’s will, opposed to his benefit. These trends are mostly out of human control. Uncertainties are a critical challenge and available documents are not accurate enough even to get to a relative consensus. However, there are enough documents for doing more precise, accurate and extensive scientific researches. MENA drought is an example. Regarding MENA drought, usual climate prediction methods, such as statistical trends or modelling by using a particular component (i.e. IPCC reports on the basis of co2 emission trends) do have unreliable outputs. According to MENA drought, statistical trends are not reliable to predict the future climate trends and it could not be diverted into a predictable phenomenon by using one or more quantitative component(s) in the form of a mathematical model.

However, the IPCC reports are mathematically accurate enough, because they use measurable data and particular components to analyses data. But there is a problem: In MENA, the components are completely varied and it’s hard to design a model to predict the climate trend or its intensity. The main disagreement with IPCC reports is produced when there are signs which imply that natural components may change the climate trends, which happened in MENA. Those climatologists whom do not trust statistic averages or trends also criticize the IPCC statistic-based reports. For instance IPCC reports are usually focused on climate change trends in Asia, meanwhile it’s clear that in order to get into such a summary, completely different areas such as Java, Lute, Himalaya and Siberia are added to each other. The IPCC reports are data-basis as well. It means they are mainly concentrated on the areas in which accurate data could be provided for scholars. So, these reports are more accurate in north Europe, because data is more comprehensive there. But not in MENA!

In MENA we should also consider these points: Regarding to IPCC the highest temperature is reported in internal Asia area and north of North America. So, it’s not mentioning the MENA climate trends (IPCC 2014). In another report about areas confronting intensive climate change, there is no information about MENA. Therefore there might be such a critic that according to IPCC reports the climate change is just because of greenhouse effect or that kind of the climate change which are anthropogenic. Emphasis on a single component (increasing the greenhouse effect) and effort to explain the trends which are generated from it is an advantage of IPCC reports.

Since, this characteristic makes the institution’s reports more logical and extensible. Nevertheless, according to what mentioned before, the climate change paradigm is somehow different in MENA. Although we should also attention that if we would emphasize on mega climate cycles’ impacts to understand and analyses MENA climate change, it is a kind of returning to the old climate change paradigm and climate epistemology of 90s. In that time, it was supposed that each mega climate change was related to solar radiation.

Anyway, we could not easily explain the long-term drought period in MENA only as a climatic extreme generated from greenhouse effect increase.

Even if the slight changes in temperature continues for a long time (the “duration” is one of the three characteristics of extremes), it could cause climate extremes because of the possibility of production and intensification of positive feedbacks. But, the anthropogenic temperature changes are usually systematic. Even The IPCC doesn’t claim that the global warming has yet generated such an intensive drought in a wide area, as we observe in MENA.
So, according to collected documents, there is no evidence to implicate the reversibility of this kind of drought. It seems that in MENA, we are confronting a kind of climate change which we may call it as a kind of "drying up" and not drought which means converting the land into a dried area.

MENA drying up is a new particular paradigm of climate change: a kind of climate change which is not absolutely anthropogenic and in comparison with other climate change prediction scenarios (i.e. paradigm of greenhouse effect) its impacts are more intensive with more severe losses for human life.

Maybe we should consider MENA drought as a Major Climate Change. It is somehow linear, and is understood according to normal climate components of the region. It means a dry and warm region has got warmer and drier. But either abrupt climate change or a Major Climatic Change is naturally reversible. At least we could say that its reversibility is more than its uncertainty. But in MENA, it's more uncertain than certain.

It's a reality that during recent thousands years, such a climate change in MENA has always led to a dried and warmer region which might be translated into a kind of climate hyperactivity which means the land sometimes tends to intensify its normal climate characteristics and tend to present kind of hyperactivity.

Even if we assume that this kind of hyperactivity will decline in the future, but this kind of periodical hyperactivity could be analyses in a different category of climate change paradigm. The Paleo-climatological studies in MENA confirm that this kind of hyperactivity will not be reversible, because there have intensive impact and may convert the meteorological drought into hydrological droughts, and so to intensify land collapse and decease its biological potential. This kind of hyperactivity occasionally makes the land more dried and warmer.

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REFERENCES


Arab Water Council (2014). Vulnerability of arid and semi-arid regions to climate change-impacts and adaptive strategies. One part of 16 papers on “water and climate change adaptation”.


http://om.ciheam.org/om/pdf/a80/00800414.pdf


Francesco F, Caitlin W (2012). Syria: Climate Change, Drought and Social Unrest. The Center for climate and security,
exploring the security risks of climate change.


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