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Socio-economic impacts in a Changing Climate: Case Study Syria

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Abstract

As a result of climate change, it is clear in the coming years to provide an instability for conflict zones. Climate change has potential socio-economic consequences in addition to environmental impacts. Drought is one of the result of climate change especially in Mediterranean. It can also increase by unsustainable government policies and effects quality of life of people. Decreasing of water resources and rural land using force people to migrate from rural areas to urban areas as a consequence of low productivity from agriculture and animal husbandry, rising of food prices and decreasing of wealth level. Results of climate change have differences depends on features of countries as climate vulnerability, social policies, ethnicity. In this study we evaluate socio-economic impacts of 2006-2010 severe drought in Syria There are a number of studies in which the Syrian war is overstated by the excess of the relationship as much as the work that expresses the emergence of climate changes as a result. We observed that in addition current problems in Syria, drought between 2007 and 2010 contributed to uprising in 2011 and consequently to immigration, conflict and terrorism. It is not wrong to evaluate that the impact of the spread of conflicts inherited from generations before the arid years of succession is at least as effective as the causes of other conflicts. The long-term effects of climate change, which has begun to emerge, indicate potential conflicts that can develop in water-scarce, multicultural geographies, particularly in the Middle East.

Keywords: Syria, Immigration, drought, climate change, climate oscillation

Introduction

The Fertile Crescent (FC) region is around The Nile Basin of Egypt in North Africa, Mesopotamia, Anatolia, Mediterranean and Red Sea and one of the first domestication centers in the world where transition from hunting and gathering life to settled life some 10.000 years ago (Gepts 2010). Syria geographically is located in large part of FC region and is both a Mediterranean and a MENA (Middle East and North Africa) country where climatic trends display increasing temperature and drier winters and driest winters occurred more frequent in past 20 years (Hoerling et al. 2012). NASA studies show that drought in eastern Mediterranean Levant region is likely the worst drought of the past nine centuries (Gray 2016). Moreover, analysis in the region displays 50-60 additional warm days by 2100 due to increasing of temperature 0.5-0.9° C per decade and decreasing of annual rainfall by up to 25 percent in the 2060s (Åkesson and Falk 2015). Droughts in Syria have occurred during almost every second year over the past half century, and may become even more frequent in the future (Al-Riffai et al. 2012). According to Zakhem and Kattaa (2016) Syrian groundwater resources are obviously affected by climate change (Zakhem and Kattaa 2016).

According to IPCC reports human activities have contributed significantly to climate change (IPCC 2007; IPCC 2014). Since pre-industrial times, increasing emissions of greenhouse gases (GHGs) due to human activities have led to a marked increase in atmospheric GHG concentrations. Total anthropogenic GHG emissions were the highest in human history from 2000 to 2010 and reached 49 (±4.5) GtCO2eq/yr in 2010" (IPCC 2014). It is described that land degradation resulting from

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various factors including climatic variations and human activities (IPCC 2007). It is observed that 2006-2007 highest drought in FC occurred when total anthropogenic GHG emissions were the highest level in the world. Moreover there were six severe droughts in 20th century which continued maximum two seasons (Mohtadi 2012) before 2006-2011 drought in Syria. The severe drought experienced in FC in the winter of 2006-2007 because of climate change and wrong agricultural politics (Kelley et al. 2015; Müller et al. 2016). As a result, the long period of the drought between 2006 and 2011 has been devastating.

Syria has very arid, arid, humid, semi-arid, and semi humid climatic zones (Fig.1). Different types of climate arise from having geographically differences in the country as the coastal areas in Mediterranean, desert in the middle and forestry regions North and North-western regions (Albrecht et al. 2014). Therefore, Mediterranean, Middle East and Africa countries are vulnerable to climate change because of current and future climatic conditions. According to Mathbout et al. (2018) 2007–2010 drought was the driest period in the instrumental record, happening just before the onset of the recent conflict in Syria (Mathbout et al. 2018).

In addition to environmental factors, growing population, unsustainable policies, poor governance and social problems like ethnically fractionalization in the region increase climate vulnerability. The literature displays that countries like Syria, Chad, Afghanistan are the example to these regions. Also non-state armed groups (NSAG) in the regions gain strengths more by climate - related disasters (Nett and Rüttinger 2016).

Farmer businesses are vulnerable to climate fluctuations due to many factors, such as not changing prime weighing methods, not renewing and improving irrigation systems, not applying the decisions made for drought and finally not taking the necessary economic measures to remove groundwater. It can not be said that the firing of quarrels based on past centuries has not been influenced by the mentioned factors. Migration can also promote conflict, through increased competition for resources and services, and tensions due to ethnic and demographic changes (URL 1). Family businesses related to agricultural activities have abandoned production vacancies and forced the demand for managers to share scarce resources. Several literatures point out that records are already becoming more and more difficult due to the sharing of scarce resources, climate fluctuations and increasing

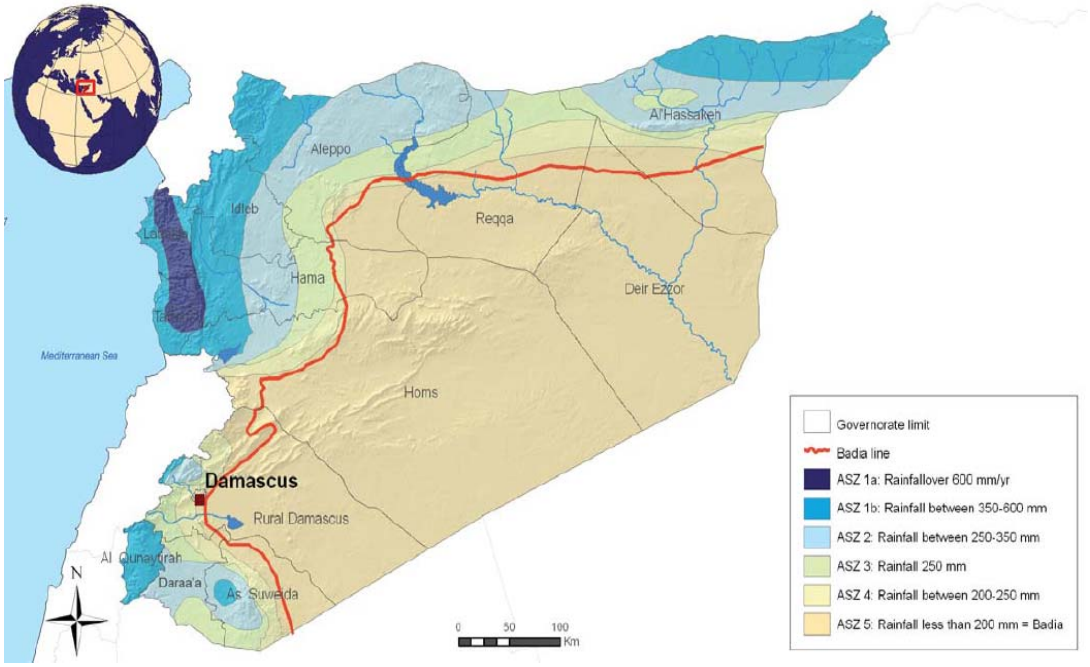

Fig 1: Climatic zones in Syria (IFAD 2010)

Despite the fact that the initiator of crushing is the suppression of innocent actions with excessive force, socioeconomic dissatisfaction based on long years, the tensions brought about by the drought that can be defined as the effect of climate change on the region have begun the destruction. The agricultural land has been abandoned and state authority has left its place to local and international terrorist organizations. This change has accelerated the migration even more rapidly.

The study observes that human induced degradation for severe drought in Syria are 2-3 times more likely than natural influences (Kelley et al. 2015). There is a reciprocal influence between climate and economic. Water and agricultural conditions have played role in the deterioration of Syria's economic situations but also economic policies of government affected the water and agricultural conditions as well. Effects of drought were acute in Syria due to their agricultural economy and social structure is sensitive to environmental stress. For example, drought in 2007 caused decreasing of 78,9% of wheat production and unprecedented rise in Syrian food prices (Albrecht et al. 2014; Kelley et al. 2015) and approximately 10 million people migrated due to conflict and drought (Nett and Rüttinger 2016).

This study analysis drought and socioeconomic consequences in Syria. The literature shows that in the Syrian Arab Republic about 1.5-2 million people –predominantly small-scale farmers and herders with ownership less than 50 heads- migrated from rural areas to urban areas because of drought (Kelley et al. 2015; Mohtadi 2012). Mass migrations from rural areas have been decreased severely agricultural production. According to recently report of UN Food and Agriculture Organization Syria is one of the 37 countries in the world which requires external food assistance where about 6.5 million people are food insecure and 4 million people are at risk of food insecurity as of September 2017 because of conflict and drought (FAO 2017). Agriculture is vulnerable to climate change because agriculture is strongly affected by climate conditions and also water existence. In this respect the region should be assisted with integrated approach including water resources management, agriculture and animal husbandry sustainability.

Materials and Methods

Data sources

In this study our main data sources are Fourth and the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Climate Diplomacy report of Federal Foreign Office and Adelphi, NASA's Gravity Recovery and Climate Experiment (GRACE), population data of World Bank, water resources data in Syrian Arab Republic Country Report. In addition to these, scholars who were given reference in this study were used some of the other datasets which are Munich RE NatCatSERVICE, UEACRU version 3.1(Jones and Harris 2008; Kelley et al. 2015; New et al. 2000), Global Precipitation Climatology Centre v6(Schneider et al. 2008), GHCN beta version 2(Vose et al. 1992), UCDP (Uppsala Conflict Data Program) / PRIO Armed Conflict Dataset (Gleditsch et al. 2002; Schleussner et al. 2016; Themnér and Wallensteen 2011)

Munich RE NatCatSERVICE provides State-of-the–art estimates of economic damages related to natural hazards which is developed for private sector. Precipitation datasets are taken from UEACRU v3.1, Global Precipitation Climatology Centre v6 and GHCN beta version 2. CRU v3.1 can also provide data of surface temperature. Armed conflicts data are collected openly from UCDP (Uppsala Conflict Data Program) / PRIO Armed Conflict Dataset (Gleditsch et al. 2002; Schleussner et al. 2016; Themnér and Wallensteen 2011). These data are described in Gleditsch et al. (2002) and it counts all cases with more than 25 battle-related deaths globally.

The methods which are used while scholars evaluate drought, immigration and conflict in Syria are remote sensing, climate models, ECA method, statistical methods.

Remote Sensing: Remote sensing precipitation product (Precipitation Estimation from Remotely Sensed Information Using Artificial Neural Networks (PERSIANN)-CDR are used while prediction of precipitation and analyses spatial trends where data is not available

(Sorooshian et al. 2014). Google Earth Engine provides to calculate monthly precipitation predicts for the entire basins.

NDVI (Normalized Difference Vegetation Index) a images are used to explore irrigated crops and classify the irrigated areas as a simple graphical indicator(Chander et al. 2009; Tucker 1979; Wu and De Pauw 2011).
Modified Normalized Difference Water Index (MNDWI) are used to detect open water(Xu 2006). Literature has shown that it's more reliable than the NDVI (Müller et al. 2016).

Global Climate models. Climate models ensure viewing response of the climate system to numerous forcing and making projections of future climate. Some of the climate models are Atmosphere–Ocean General Circulation Models (AOGCMs), Earth System Models (ESM), Earth System Models of Intermediate Complexity (EMICs), The Coupled Model Intercomparison Project Phase 3 (CMIP3), The Coupled Model Intercomparison Project Phase 5 (CMIP5) (Flato et al. 2013).

Climate models CMIP3 and CMIP5 have been evaulated respectively in Fourth Assessment Report (AR4) and Fifth Assessment Report (AR5) of IPCC and their model performances are obviously similar(Flato et al. 2013). Published literature is less for CMIP5 models however CMIP5 involves a much more comprehensive suite of model experiments than was available in the preceding CMIP3 results assessed in the AR4 (Meehl et al. 2007) CMIP5 collections include Atmosphere–Ocean General Circulation Models (AOGCMs), Earth System Models(ESMs), Earth System Models of Intermediate Complexity (EMICs).

Statistical analyses: Violence of socio-economic consequences in a warming climate are associated with ethnic division in some of the literature (Nett and Rüttinger 2016; Schleussner et al. 2016). Furthermore ethnically fractionalization for countries is based on indices (Alesina et al. 2003) which is used on country classification by (Schleussner et al. 2016).

Evaluation of socio-economic impacts on changing climate is done in a statistical framework by regressing the outcomes. Linear regression analyses are supported by remote sensing observations and a study in Yarmouk Basin in Syria reveal the relation between Syrian conflict and refuge crisis and stream flow increase due to affected the irrigation demand and water management applications (Müller et al. 2016).

Water resources and agricultural assessment in Syria

There are 7 hydrological basins in Syria (Fig 2) and one of them is Syrian Desert Badia which is the largest basin area and very arid climatic zone. Euphrates basin provides major water resource of Syria which is almost 46% of total water resources (Table 1). Estimates display that Euphrates River flow may reduce by 29% - 73% as a result of 20% to 25% reduced rainfall amounts in dry period between April and September for Middle East and Mediterranean countries by 2050 (Trondalen 2009).

Syria had already limited water resources with growing irrigated areas and population before drought in 2006 (Müller et al. 2016). Syria population has been growth steadily until 2011. It reached to 19 million in 2006 and 21 million in 2011 while it is almost 9 million in 1980s. Between 2003-2007 about 1.2-1.5 million Iraqi refugees were increased population in Syria (Kelley et al. 2015). Growing population results created pressure on limited water resources already in beginning of 2000s (Kaisi et al. 2004) hence occurrence of drought in 2006 had more detrimental effect. Drought has forced millions of people to migrate. As a result of drought, immigration and terrorism in Syria, population in 2017 decreased to level of 2005.

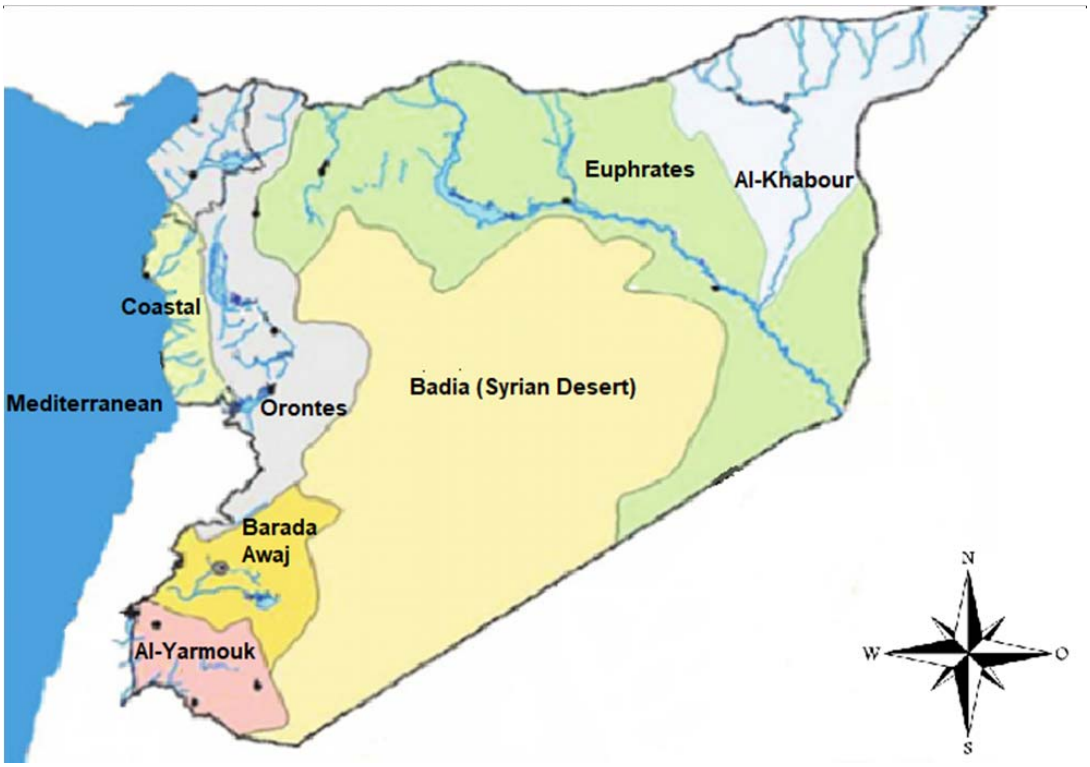

Fig 2. River basins in Syria (Mourad and Berndtsson 2011)

Table 1. Water resources in Syria before drought in 2006-2007 (Kaisi et al. 2004)

	Hydrological basins							
	Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris & Khabour	Euphrates & Aleppo	Total
Surface ($m.m^3$)	19	168	152	1036	1453	735	7073	10635
Ground ($m.m^3$)	774	249	168	1499	726	1493	346	5256
Total ($m.m^3$)	793	417	320	2535	2179	2228	7419	15891
Rate (%)	6	3	2	16	13	14	46	

Although Syria is a water scarce country, government between 1997 and 2000 supported unsustainable policies with subsidies for irrigation projects, agricultural production, quota system, land redistribution (Kelley et al. 2015; Nett and Rüttinger 2016). These policies increased Syria's agricultural productivity unsustainable and led to increase in water withdrawals. For example overuse of groundwater has been caused drying of Khabur River in Syria (Kelley et al. 2015). According to NASA's Gravity Recovery and Climate Experiment (GRACE) satellites, from beginning of 2003 up to 2009 Tigris and Euphrates river basins lost total 144 km^3 (Volume of the Dead Sea is almost 147 km^3) freshwater and pumping of ground water contributed to the loss approximately 60% of total lost which is approximately 90 km^3 (Buis et al. 2013). It's the second fastest rate of groundwater storage loss on Earth, after India (Buis et al. 2013). Syria's vulnerability to drought has been increased due to reduced supply of groundwater. Consequently, agricultural productivity decreased.

Management of agriculture politics in drought vulnerable climate is significant for regions in order to provide sustainability. Syria's weakness is vulnerability of agriculture to climate change and its consequences are related with more water scarcity. Main hardships for water resources management in Syria which are observed: climate change/variation, reservoir sedimentation, groundwater over-pumping, growing urban population, growing urban demand and reduced environmental flow (Schmandt and Kibaroğlu 2016).

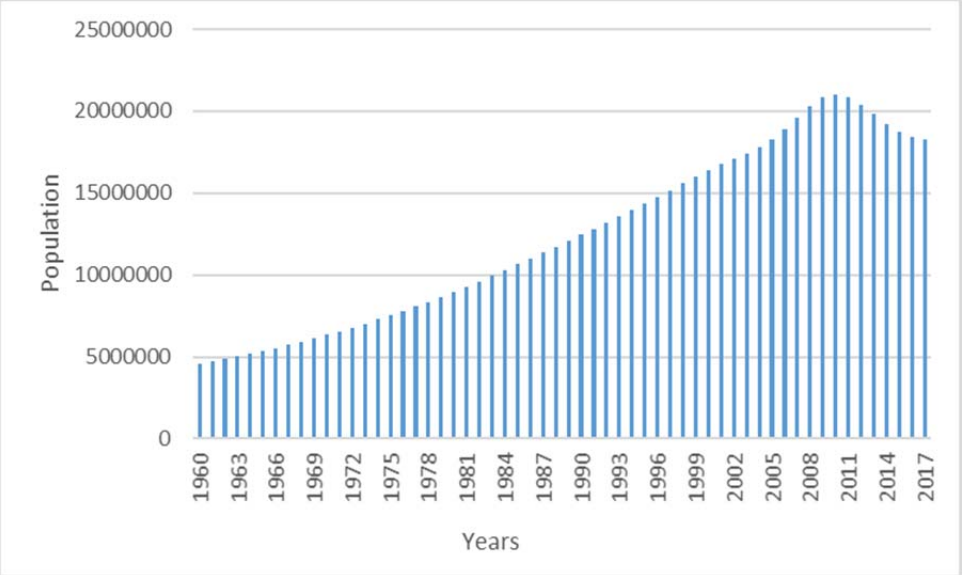

Fig. 3 Syria's population (The World Bank 2017; United Nations 2017)

Immigration and conflict

Reduction of water resources and reduced productivity of agricultural land are successive outcomes. These results create displacing of people from rural to urban centers. Consequently, unemployment and poverty increase in the society. 2006-2011 drought in Syria caused to these unsteady conditions and socio-economic hardships.

While Syrian people displace from rural to urban, they also have started to migrate to neighbor countries and Europe. According to data of Republic of Turkey Ministry of Interior Directorate General of Migration Management, irregular Syrian migrant caught in 2016 is 69755 (Fig. 4). Due to conflict in Syria approximately 1 million people migrated from Syria to Turkey between April 2011 and May 2014 (Republic of Turkey Ministry of Interior Directorate General of Migration Management 2018). The subsequent country is Afghanistan with 31360 immigrant (Republic of Turkey Ministry of Interior Directorate General of Migration Management 2018) where the climate related problem is obvious in climate diplomacy report (Nett and Rüttinger 2016).

The Syrian conflict and subsequent refuge crisis affected the irrigation demand and water resources management practice. Consequently, streamflow increased. For example, 150% increase on streamflow has been occurred into Al-wehda reservoir (Müller et al. 2016)

Except of drought, another problem for Syria is NSAG. Non-state and one-sided organized violence categories create terrorism with high levels of violence in the region and evolve easier in socio-economical sensitive region. While poverty and unemployment increase in Syria, monthly payment of NSAG to the fighters enhances their power(Nett and Rüttinger 2016).

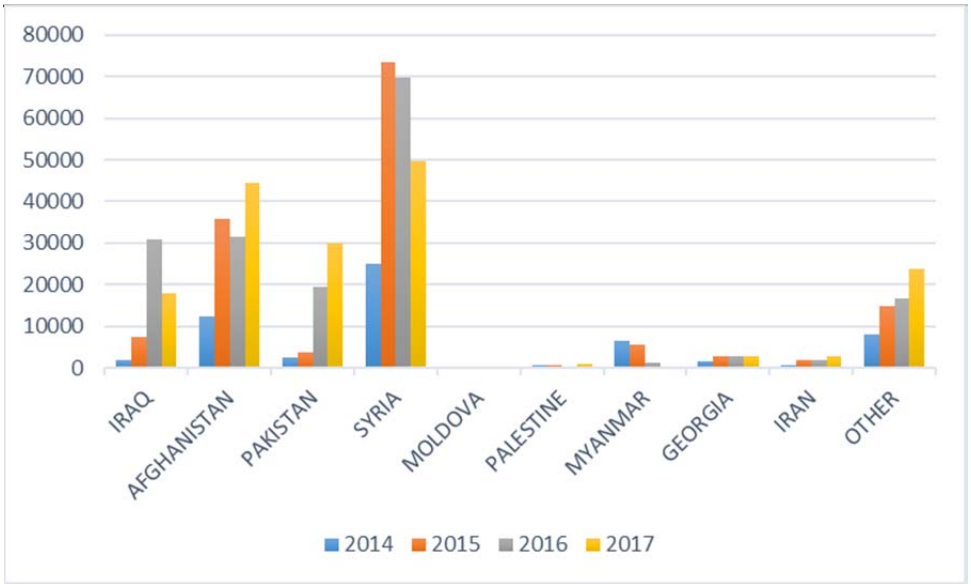

Fig. 4 Distribution of irregular migrants by nationality in Turkey

According to Uppsala Conflict Data Program NSAG is active predominantly in Euphrates basin and control large part of Euphrates including Tabqa Dam which is critical for water, food, energy(Nett and Rüttinger 2016; Shamout 2014). Subsequent to Euphrates, respectively Tigris & Al Khabour and Orontes basins are active with NSAG. Due to poor governance and increasing effects of war in Syria, NSAG was able to locate in important water resources in Syria and threat water and food security.

Discussion and conclusion

Theses on climate and history relation are not considered good. The problems of the concept of global climate change have an identity that transcends political boundaries, and even does not recognize boundaries. How the climate influences and shapes the history constantly gives new result.
Immigration or forced displacement of established populations is developing a serious multiplier effect on the impacts of global climate change.

In the view of many commentators, the Syrian civil war was effected by an anthropogenic climate change. Syria had already water problem before 5 years' drought in 2006 however rapid population growth and water mismanagement by the unsustainable policies followings were contributed to increasing of climate vulnerability and consequently severely drought started. Pressure of climate change in Syria has contributed to mass migration, armed-conflict, ethnically division. However, while some of scientific literature displays that climate-related consequences contribute armed conflict (Burke et al. 2009; Nett and Rüttinger 2016) and armed conflict is associated with climate variability (Schleussner et al. 2016), some of the other scientific literature displays the impacts of climate change is not hardy related with armed-conflict (Gleditsch 2012; Slettebak 2012). While much research has concentrated on impacts of water scarcity in conflict(Gleick 2014; Kelley et al. 2015), an analysis also displayed that conflict can significantly change the basin scale water balance (Müller et al. 2016).

a) In addition to sustainable water and agriculture management in line with climate change, Integrated Water Resources Management (IWRM) programs must be inevitable for Syria. In this context, developing and implementing a National IWRM program. Developing and implementing a National, Regional and international drought Strategy

b) A strategy should be developed to control the operation of underground waters.
c) Diversity of water resources should be ensured (use water should be improved in agriculture), irrigation systems suitable for drought should be developed by abandoning open irrigation system.

While it is known that the most destructive impact of climate change is in agriculture societies, families who are engaged in agricultural activity have to abandon their increasingly inefficient soil and at the same time produce a vacuum effect. In general, a social structure based on violence and illegalness develops instead of agricultural and subcultural agricultural activities. Agriculture is at the forefront of sectoral impacts that will be most affected by climate change, and national and international programs should be developed to reduce tension in areas where certain socioeconomic dissatisfaction exists, coordinated with the implementation of modern agricultural techniques, and to improve living standards. Because, as in the case of Syria, the tensions that are influential in climate fluctuations are far beyond political boundaries.

There are a number of studies in which the Syrian war is overstated by the excess of the relationship as much as the work that expresses the emergence of climate changes as a result (Selby et al. 2017). Climate oscillations are as old as human history on the lives of people, and the consequences have been related to the whole humanity. In other words, the interaction has become more effective in society, which has replaced its life with its production based on land/farm. The first affected regions in the Syrian war with the chronological approach were the regions where the agriculture-related production took place. The interaction with the socio-economic and historically dependent population of production societies has not been delayed. But later the spread of the war and its infiltration of the whole country was a result of external forces approaches in the region. Climate oscillations have been the most effective trigger mechanisms at the beginning of the great migrations that have affected the results of all neighboring countries.

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