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Climate Change and Ecological Migration: A Study of Villages in the Province of Khuzestan, Iran

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Although the most extensive immigration flows among urban and rural settlements have so far been economic migrations, climate change has recently become a decisive factor for migration in many parts of the world with ecological migration becoming the dominant model in these demographic movements. Khuzestan province with a strategic position in southwest of Iran and with a 30% share of rural population is one of the provinces that has been affected by widespread climate change over the past two decades, experiencing massive population movements, especially in the rural areas. Studies have shown that the increasing trend of temperature and the decreasing trend of precipitation are the most important and most obvious outcomes of climate change that has provided a platform for population displacement in rural areas of Khuzestan. This enormous flow in the rural parts of the province has become a multi-level (local, regional, national and even international) challenge. The purpose of this study is to investigate and analyze the effects of climate change on demographic movements in the rural settlements of Khuzestan province. The study is descriptive-analytic and the information is extracted from the database of the Statistics Center of Iran. Statistical analysis has shown that the decline in the rates of rural population growth from -0.2 in 1986 to -4.6 in 2017 and the evacuation of more than 2,398 villages over 1986–2017 have been directly and indirectly related to the diverse effects of climate change.

Keywords: climate change, ecological migration, global warming, climate migration, Khuzestan.

Introduction

Studies have shown that the earth will be warmer in the future (Arnell, 2004; Gammans et al., 2016) and the global temperatures will increase by 2.5 to 4.5°C by the end of the 21st century (Rosegrant & Cline, 2003). The report from Intergovernmental Panel on Climate Change (IPCC) indicates that most countries will experience an increase in temperature, more frequent heat waves, more stressed water resources, desertification, and periods of heavy precipitation (IPCC, 2014). Therefore, climate change is an important driving force (Hugo, 2008), influencing human beings' habitat almost all over the world with varying degrees of severity. That is why its impacts have recently gained the attention of an increasing number of researchers.

Climate change will have wide-ranging effects on the environment as well as the relevant socio-economic sectors including water resources, agriculture and food security, human health, terrestrial ecosystems, biodiversity, and coastal zones (Arcanjo, 2018). Changes in rainfall patterns are likely to lead to severe water shortages and/or flooding (FAO, 2017). Melting of glaciers can cause flooding and soil erosion. Also, rising temperatures will cause shifts in crop growing seasons, which affects food security and brings about changes in the distribution of disease vectors, putting more people at risk of diseases such as malaria and dengue fever (UNEP, 2012). However, the widespread redistribution of the population can be considered as one of the most important spatial implications of climate change, where the climate-related refugees appear as a world scale challenge. Climate refugees refer to the people displaced across borders (national and international) in the context of climate change and disasters (IOM, 1992; UN, 2016). The Internal Displacement Monitoring Centre (IDMC) estimates that an average of at least 25.4 million people are displaced by "disasters triggered by natural hazards" each year, a number that is expected to increase (IDMC & NRC, 2016). Indeed, the impact of climate change on migration is through increases in the frequency and intensity of weather and climate risks (Rogers, 2017). These climate-oriented risks can be sudden-onset events (e.g.,

tropical storms, heavy rains, floods, and droughts) or slow-onset ones (e.g., sea-level rise, salinization, and desertification) (Arcanjo, 2018).

In the context of climate change, migration has multiple causes. While the environmental change (including climate change) is an acknowledged driver of displacement and migration, it is typically one of many interconnected drivers on which people base their decisions to move. The combination of climate-related risks with socio-economic drivers increases the vulnerability of agriculture, leads to loss of livelihoods, and triggers migration. Environmental factors are indeed ranked highly in the first systematic theories of migration. In relation to climate change, two elements concerning migration are particularly relevant. One is that the process is accelerating in many parts of the world and the second is that its effects are geographically asymmetric (FAO, 2017). Experts generally agree that the environment is just one of the many reasons that prompt people to migrate, sometimes operating on its own but more often through other mechanisms, particularly loss of livelihoods affected by environmental disruption. The convergence of climatic risks with other socio-economic stressors increases vulnerability and contributes to the loss of livelihoods. This situation can trigger migration from rural areas. In developing countries, the agricultural sectors (crops and livestock, fisheries and aquaculture and forestry) absorb 26% of the total damage and losses from climate-related disasters. These impacts aggravate food insecurity and intensify migration around the world (IDMC & NRC, 2016).

Nevertheless, the impact of climate change in all countries, even in urban and rural settlements, has not been the same. Typically, rural areas experience climate change impacts significantly due to the high dependence on agriculture and on the elements of the natural environment (land, water resources, fertile soil, rainfall, etc.). In recent years, Iran, as a country in the world's belt of dry land (Mohammadi and Shanbehpour, 2018), has heavily been involved with the consequences of climate change. Rapid redistribution of population is the most

important and the worst effect of climate change in Iran, which is mainly from the origin of certain provinces to specific destinations (Shiva & Molana, 2018).

Khuzestan is known as the center of Iran's oil industry, with a population of 4,710,509 in 2018. With its total of 27 townships, it is the fifth most populated province in Iran (Iran's Statistics Center, 2018). The proportion of rural population in this province is 30%. Khuzestan as a borderline province with Iraq is located in the south-west of Iran. In addition to the impacts from oil industry, the province's international agricultural function, its multilingual ethno-social texture, its severe heat in the spring and summer, the challenge of "dust storms", and being at the forefront of the 8-year war with Iraq are the most important characteristics of the province. Also, according to the Statistics Center of Iran, Khuzestan is known as the most emigrant-pole in Iran (according to the results of the last census in 2016). Based on available statistics, more than 50% of them have been rural immigrants (Iran's Statistics Center, 2017).

Based on what was said, the most important consequences of climate change between 1998 and 2017 in Khuzestan province are temperature increase and precipitation decrease. Nevertheless, climate change in this province does not go down to these two factors and has numerous consequences. The most important ones are:

- *The increase of heat waves period.* The study of heat waves has shown that the frequency, durability and severity of heat waves in Khuzestan province have grown significantly over the past two decades (Darand, 2014; Khuzestan Meteorological Organization, 2018).
- *The intensification of dust storms.* Dust storms began in 2001, and the largest number of polluted days happened in 2012 (73 days) and 2009 (66 days) per year (Mohammadi, 2014).
- *The increasing rate of crop water requirements.* Studies on wheat cultivation in Behbahan, Ahvaz, Dezful and Karkheh have shown the increase in water requirement of 723, 508, 339 and 488 m³, respectively (Hemadi et al., 2011).
- *The increase of fire, especially in forests, farms and wetlands.* One of the most important examples of forest fairing in Khuzestan province has been the firing of HUR ALAZIM¹ wetland from 2017 to 2018.
- *The increase of droughts.* A study on the drought trend in Khuzestan province (Arvin & Eskandarian, 2017) shows that the drought trend is increasing in more than 85% of the province, and the mild and moderate droughts have the highest probability of occurrence in the province, with the return period of 3 and 10 years, respectively.
- *The reduction of the quality and quantity of surface water.* In addition to reducing water resources to provide drinking water to the cities of the province, especially the southern cities, extreme droughts in the last decade have reduced water quality and caused water salinity.
- *The reduction of hydroelectric power generation.* Reduction of precipitation has reduced the water storage of dams in recent years and, as a result, hydroelectric production has decreased so that the production of the Dez Dam was reduced to 50% of annual average in 2018.
- *The reduction of agricultural areas.* By reducing water resources in agriculture, the cultivated lands and, in particular, the rain-fed lands have decreased in Khuzestan province and, in 2018, rice cultivation was banned. Reducing the cultivation area reduces the production, which threatens food security.
- *The reduction of river fluxes and high salinity.* This has exacerbated environmental pollution of Karkheh, Karun and Dez in urban environments.
- *Social strain caused by the shortage of drinking water.* In 2018, the salinity of surface water resources and the impossibility of purification caused the challenge of supplying drinking water in Khorramshahr and Abadan cities.
- *The policy of transferring water from river branches to other provinces.* Reducing water resources in the interior regions of Iran has caused many projects to be carried out to transfer water from river branches of

¹ Hur al-azim (Hawizeh Marshes) is a complex of marshes that straddle the Iraq and Iran border. The marshes are fed by two branches of the Tigris River (the Al-Musharrah and Al-Kahla) in Iraq and Karkheh River in Iran.

Khuzestan (Karkheh, Karun, etc.), which has significantly reduced the level of rivers and is still continued.

Ultimately, immigration is considered as an outcome of all the environmental challenges posed by climate change in Khuzestan province. By investigating the consequences of climate change in Khuzestan, the current study aims at analyzing the effects of increasing trends of temperature and decreasing of precipitation as the main climate change indicators on rural migration and the evacuation of villages in this province.

Climate change and ecological migration

Migration is a costly process but can be induced by a number of factors amongst which economic opportunities, civil and international conflicts, religious and ethnic clashes, and climate change feature as the most common ones (UNEP, 2012). One of the early studies carried out for an Intergovernmental Panel on Climate Change assessment report (IPCC, 2007) has identified human migration as the greatest single impact of climate change. This was followed by concerns raised in International Organization for Migration (IOM, 1992). The dramatic increase in mass displacements and the anticipation of substantial rise in forced migration flows, like the climate change, has rendered large areas in different parts of the world uninhabitable.

The links between climate and human migration are not new (Beckman and Page 2008). Ellen Churchill Semple later wrote that “the search for better land, milder climate and easier conditions of living starts many a movement of people which, in view of their purpose, necessarily leads them into an environment sharply contrasted to their original habitat” (Semple, 1911). Since the end of the 1980s, there have been numerous theoretical publications on international migration, but without any mention of environmental factors (Parry et al., 2004). The term “environmental refugees” was first coined in 1985 as a title of a report for the United Nations Environment Program (El-Hinnawi, 1985) and afterwards became widespread with the emergence of the effects of climate change on human settlements

and massive population movements at national and international levels.

As an old phenomenon and process of population change, migration is the movement of people from place to place² for living or working purposes (Huzdik, 2014; UN, 2016). Lee (1966) considered all movements including permanent or semi-permanent changes of residence, whether forced or voluntary, as migration (Lee, 1966). With regard to all the important effective factors on a movement flow, migration is the temporary or permanent movement of individuals or groups of people from one geographic location to another for various reasons ranging from better employment possibilities to persecution. Lee (1966) was the first to formulate migration in a push-pull framework on an individual level, looking at both the supply and the demand side of migration. Lewinsky's hypothesis of mobility transition (1971) argues that migration is part of the economic and social changes inherent in the modernization process (Zelinsky, 1971). Faist (2000) with a category of migration theories defined the cause of migration as including the three levels of micro-level (e.g., improving survival, wealth, etc.), meso-level (e.g., social ties), and macro-level (e.g., income and employment opportunities differentials) (Faist, 2000). As the current approach to migration analysis in recent years, the neoclassical economics approach to migration is based on the premise that individuals will migrate in order to improve their standard of living (James, 2009).

The migration stimulus shows that the economical (Rogers, 2017), social (Zipf, 1949; Zelinsky, 1971; Ravenstein, 1972; IOM, 1992; etc.) and political factors (Zetter, 2015; Terry, 2009) have recently played a major role in starting and continuing migration flows around the world. Nevertheless, in the last decade, nature has become the most powerful source of demographic displacement on national and international levels. In fact, we talk about people's migration because of climate-induced events such as natural disasters, droughts, rising sea levels, lack of sufficient rainfall for agriculture, and the like. As the Intergovernmental

² Although immigration is always accompanied by displacement, some times that migrants do not have the ability to move, a type of *mental migration* will happen. This type of immigration involves those who, for various reasons, have a high inclination to migrate but for some reason cannot move. So they have to live and work in a place where they have no interest and motivation.

Panel on Climate Change (IPCC) noted, the greatest single impact of climate change might be on human migration – with millions of people displaced by shoreline erosion, coastal flooding and agricultural disruption (Jessica, 2011). Specifically, just in 2016, over 24 million people were newly displaced by sudden-onset³ climate-related hazards, such as typhoons and floods (UNDP, 2016). Regarding the existing natural challenges, experts estimate that between 50–250 million or even one billion people may migrate by the year 2050 (Christian, 2007; UN, 2016). Between 2008 and 2015, an average of 26.4 million people was displaced annually by natural-hazard-induced and climate-related disasters, and this trend is rising (IDMC & NRC, 2015). Today, the total number of international migrants, including those displaced by climate-related natural disasters, is 40% higher than that in 2000, with numbers expected to exceed 400 million by 2050 (FAO, 2016).

Scientists expect one of the main humanitarian consequences of climate change to be ecological migration or climate migration as an issue that is commonly presented as “new” or as part of “future trends” (Parry et al., 2004). The result is that ecological migration, as well as environmental migrants, is no longer a new concept or an emerging phenomenon. The quest for formulating an appropriate conception of the relationship between environmental changes and migration tends to use El-Hinnawi’s (1985) typologies as the starting point (Zetter, 2008). UNEP⁴ defines ecological migrants as “persons or groups of persons who, for compelling reasons of sudden or progressive change in the environment, are obliged to leave their habitual

homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad” (UNEP, 2012). Environmental migrants are divided into three categories by Batima (2003). She terms “refugees” those “involuntary migrants”, for whom the change in environment has been so drastic that a failure to migrate would result in death. Those “compelled” by environmental changes are termed as “environmental migrants”, and those who move “voluntarily” are categorized as “migrants”. While attention to the issue of ecological migrants has grown rapidly in recent years, the term “environmental refugee” has been in use since the 1970s, well before the climate change debate was established (Mohammadi, 2014).

Although the movement of people as a result of environmental changes is not a new phenomenon, nomadic peoples and pastoralists have been moving in response to changes in their environment. Yet, as early as 1990, the IPCC warned that “the greatest single impact of climate change could be on human migration” (IPCC, 1990, p. 20). IOM, with its emphasis on environmental degradation, has warned that larger areas of the earth have become uninhabitable as a result of climate change (IOM, 1992). Overall, the result of the existing analysis of the linkage between climate changes and migration flows shows that ecological changes could affect the movement of people in at least four different ways: the intensification of natural disasters, increased warming and drought, rising sea levels, and competition over natural resources (IOM, 2009; IPCC, 1990; UN, 2016; Zetter, 2008; NRC 2008).

Methods

This study is divided into three parts according to its quiddity and subject.

In the first part of the research, climate change trends in Khuzestan province are studied. The statistical data for this part were obtained from Khuzestan Meteorological Organization. In the first part of research,

linear regression was used to determine variables in precipitation and temperature in Khuzestan province. The linear regression model is as follows:

$$Y = \beta_0 + \beta_1 X + \epsilon$$

³ Slow-onset climate-related hazards³ include drought, desertification, salinisation, ocean acidification, glacial retreat and sea-level rise and changing trends in seasons

⁴ United Nations Environment Programme – UN Environment.

Where Y and X are dependent and independent variables, respectively, and β_0 is constants and β_1 is a slope parameter. These parameters are usually called as regression coefficients.

SPI index indicates quantify of the precipitation difference from the average for multiple timescales.

$$SPI = \frac{X - \bar{X}}{\sigma} \quad (1)$$

Where X is the amount of precipitation in a period (year, season, etc.), \bar{X} is the long-term average and σ is standard deviation of precipitation.

Table 1. *The SPI index values*

extremely wet	2.0+
very wet	1.5 to 1.99
moderately wet	1.0 to 1.49
near normal	-.99 to .99
moderately dry	-1.0 to -1.49
severely dry	-1.5 to -1.99
extremely dry	-2 and less

Source: authors.

In the second part of the research, population changes and the number of villages in Khuzestan province are studied. The purpose is to determine the effects of climate change on population movements in the rural settlements of Khuzestan province. The demographic database in this section is the Iranian Statistics Center and the Khuzestan Governorate. In the analysis of rural migration, demographic balance and

indices of demographic growth and migration condition (immigration and emigration) have been studied. The analysis was based on Formula (2).

$$SPI = \frac{(N + I) - (M + E)}{P} * 100 \quad (2)$$

In Formula (2), N is number of births, I is immigration, M is mortality, E is emigration and p refers to population. The temporal analysis of changes in the number of villages in the province over a 45-year period between 1971 and 2017 was also carried out using the Khuzestan governor's office information. The third part of the research seeks to prove the main hypothesis of this study, i.e., the effects of climate change on population displacement in the villages of Khuzestan province. After analyzing the selected climate change indicators at the townships level, the frequency of evacuated villages in each township was obtained and standardized. Then, the significance of climate change indices and standardized indices of evacuated villages were calculated using the Pearson correlation model (Formula 3).

$$r = \frac{\sum z_x * z_y}{n} \quad (3)$$

In Formula (3), z_x and z_y are the standard deviations of the x and y indices and n is the frequency of the indices. The Pearson correlation coefficient varies between -1 and 1 . Meanwhile, $r = 1$ represents the complete direct relationship between the two variables, $r = -1$ denotes the existence of a complete inverse relationship between the two variables. Zero correlation coefficient also indicates no linear relationship between the two variables.

Results and Discussion

The climate is an interconnected and complex system in which changes in each of the components causes changes in other components. Therefore, various methods can be used to survey the changes in this system. Changes in temperature and precipitation, as the two essential elements of the climate, can reflect climate changes. Figure 1 shows the regression of

temperature and precipitation in Khuzestan province. The temperature regression map shows that the values in all regions of Khuzestan province are positive, varying between .0083 to .0622.

By this increasing trend, the temperature of the province has increased from .25 to 1.87 degrees in the past thirty years, which is an unbearable situation due to

the high temperature of the province, especially in the warm season. These values show that if the temperature trend is the same for the next century, the temperatures will increase from .8 to 6.2 degrees Celsius in different regions of the province. The temperature trend is not the same in all regions of the province, and this is probably related to different activity levels in industry, agriculture (especially rice cultivation) and urbanization. Although most of the temperature trend is due to the central regions of the province, the highest temperature is related to these areas, too. Extensive activities in the field of oil and gas industry, the large expansion of Ahwaz and the vast rice farms can have a bearing on the higher temperature trends in this region.

Fig. 1. Regression of temperature in Khuzestan province in the study period

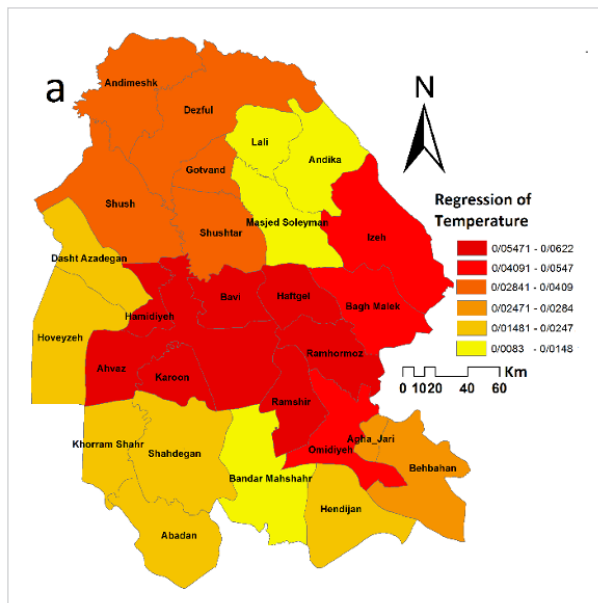


Figure 2 shows precipitation regression in the province. Variability of precipitation in the entire province is negative and changes from -1.35 to 9.07 mm per year. From the southwest to the northeast, the negative values of regression increase. North-eastern parts of the province include the Zagros Mountains, which provide much of the province's water resources. The value of -9.07 in these areas means that, during the past thirty years, more than 270 millimetres

of the precipitation, which is a large part of water resources in the province, has been lost.

Fig. 2. Regression of precipitation in Khuzestan province in the study period

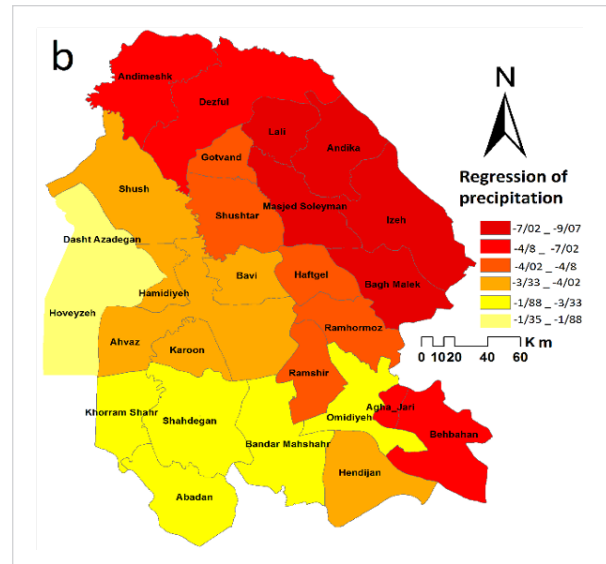
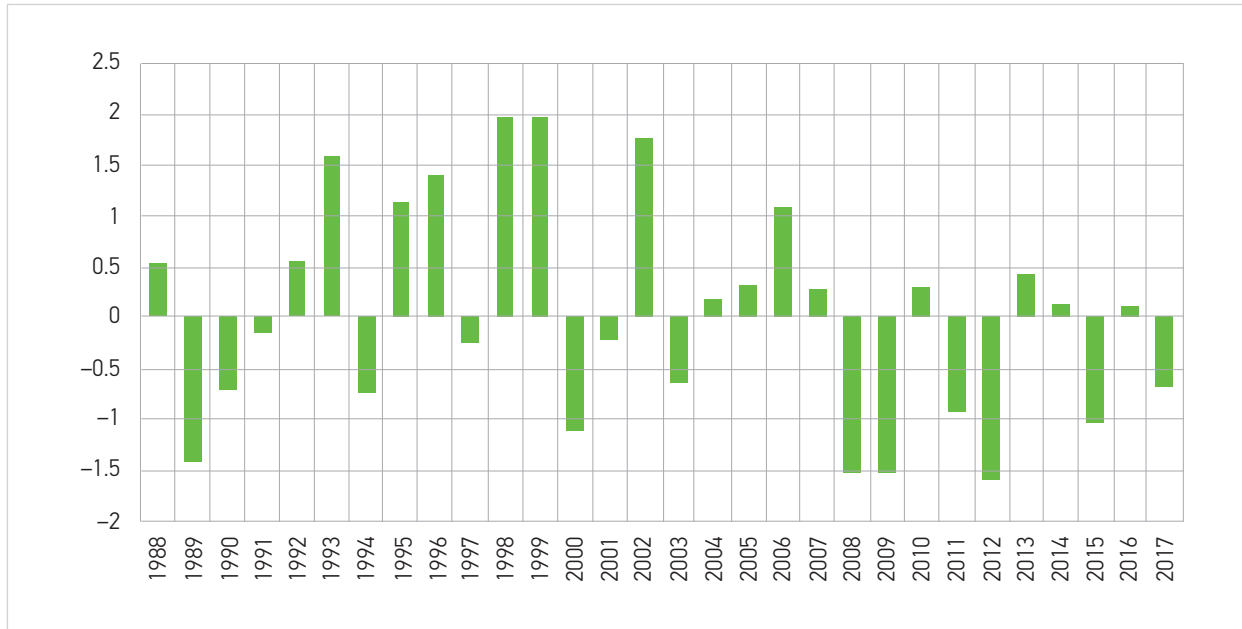


Figure 3 shows the standard precipitation index (SPI) for the entire province in 30 years. Negative values of this index show drought and, by increasing its value, the drought severity is increased. Since 2008, drought has been observed for many years in the province. The increase in droughts in the last decade has severely decreased agricultural water sources. Therefore, sources for rural income have drastically decreased.

Demographic transformation in Khuzestan province

In the past few decades of Iran's history, the profound transformations of social structures and production forces have been the main source of migration. The issue of migration began to expand in its modern sense from the first Pahlavi era in Iran (Beikmohammadi & Mokhtari, 2006, p. 168). This era coincided with the expansion of capitalist relations and modernization along with the increasing role of oil in Iran's political economy. Moreover, changes in the consumption pattern, market integration, communication

Fig. 3. Standard precipitation index (SPI) of Khuzestan province in the past 30 years

infrastructure, primary industries, economic surplus, the combination of production practices (Aghayari & hakimi, 2017, p. 32), the surplus of labour, and the dependence of farmers on money (Hesamian et al., 2015) had huge impacts on the rural settlements and led to a series of developments and the most rapid movement of population.

The study of demographic displacement in Iran has shown that Khuzestan province with a high number of immigrants has always been one of the five provinces

with significant population displacement (Statistical Center of Iran, 2014). Nevertheless, it is noteworthy that in all official census periods of Iran (except for the period between 1886 and 1896), Khuzestan has been an emigrant-source province (Statistical Center of Iran, 2014). A review of the reasons for this continuing emigration in Khuzestan has shown that climate has always been a driving factor in population deprivation. However, it has played a stronger role in emigration flows from this province in recent decades.

Table 2. Inter-provincial migration from 1971 to 2012 in Khuzestan province

Period time	Inter-provincial migration		Net migration	Ratio-percent	
	immigration	emigration		Net migration/total population	Immigration/emigration
1971–1976	65,809	74366	-8,557	-0/39	88/5
1976–1986	81,454	349098	-267,644	-9/98	23/3
1986–1996	278,336	216987	61,349	1/64	128.2
1996–2006	170,450	278662	-108,212	-2/53	61/2
2006–2012	61,092	115622	-54,530	-1/2	52/8
2012–2017	53,467	124234	-70,767	-3/1	43

(Provincial Government, 2015, p. 432)

The meta-analysis of the reasons for migration (immigration and emigration) in the conducted studies in Khuzestan province shows that in addition to the general reasons for immigration, such as job finding, education, family conditions, and life quality (Beikmohammadi & Mokhtari, 2006, p. 168), the Iran-Iraq war (Statistical Center of Iran, 2014) and the climate conditions (Hesamian et al., 2016, p. 3; Mohammadi, 2014, p. 89, Aghayari & Hakimi, 2017, p. 32) are the most important reasons for population displacement in Khuzestan. However, according to current statistics, while most immigration flows are related to the Iran-Iraq war, the climate conditions have always been a repopulation factor in Khuzestan province. Studies show that the climate has shown its role as a driver for population displacement in Khuzestan since 1996.

From this year onwards, with a widespread climate and consequently environmental change, a new type of migration has emerged in Khuzestan, which has turned into a strong demographic stream especially in rural areas. Now the main question is how the climate and environment have become a driving force for migration in rural parts of Khuzestan province.

Rural emigration in Khuzestan province

Although some Iranian institutions report the onset of reverse migration, the last demographic statistics in 2016 do not confirm this claim, with only 15.6% of immigrations to the villages. These statistics also show that 33,000 villages in the entire country are vacant (Statistical Center of Iran, 2016). Khuzestan is one of the provinces with a large number of evacuated villages.

Table 3. Transformations of rural population in Khuzestan province

Time period year	Total population person	Rural population person	Rural population growth rate %	Villages number	
				Villages with more than 3 households	Vacant villages
2012–2017	4,710,509	1,151,596	↑ (-4.6)	3,999	2,398 ↑
2006–2012	4,531,720	1,301,268	-1.9	4,055	2,364
1996–2006	4,274,979	1,356,680	-0.4	4,421	1,868
1986–1996	3,746,722	1,367,945	(-0.2)	4,567	1,217

Reference: The author's calculations based on the statistics of Iran's Statistics Center

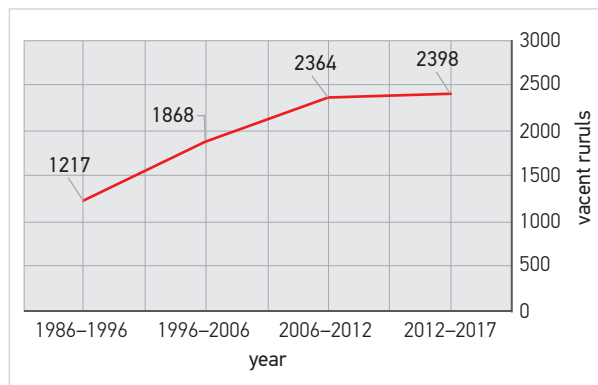
The survey of demographic transformations in different periods of this province's census shows that over the course of nearly 20 years, the number of evacuated villages has risen from 1,217 to 2,398. During the same period, the rural population has experienced a rapid negative growth from (-0.2) to (-4.6).

Studies show that, in the past two decades, immigration has been the most important reason for the negative growth of rural population and, consequently, the depletion of villages from population in Khuzestan. The indicator of "absolute increase population" in rural parts of Khuzestan between 1986 to 2017 has shown that emigration has contributed to the negative growth rate of the number of villages from 1,217 to 2,398. That

Fig. 4. The growth rate of rural population in Khuzestan province (1986–2017)



Fig. 5. The number of evacuated villages in Khuzestan province (1986–2017)



is, a two-fold negative growth (over 30 years) of villages evacuated as a result of climate change.

Emigration was previously considered an “economical” and is recently known as an “environmental challenge”. The villages of Khuzestan are heavily influenced by environmental changes because of their potential in the field of agricultural activities (agriculture, animal husbandry, beekeeping, fishing and fisheries). Hence, the recession of agricultural activities due to the consequences of climate change over the past two decades can be considered as the most important reason for the negative growth rate of population in the villages and climate emigration from this province. Meanwhile, over the last four census periods, 35–40% of rural migrants have consistently changed their jobs as an emigration reason (Statistical Center of Iran, 2016). This high rate of job migration is another result of the effect of climate change on agriculture inadequacy. Importantly, with the deepening of climate change effects and, consequently, the long-term fixed or negative population growth rates in more than 65% of the villages, the phenomena of “rural escape” and “rural

evacuation” have become a serious threat. Due to the strategic location of Khuzestan, the threat is considerable with regard to territorial, food and environmental security since climatic emigration brings about challenges for the origin and the destination.

From 1986 to 2017, during the 31-year period, 1,181 rural points have been evacuated for reasons such as drought, reduced rainfall, land use change, and similar causes, according to statistics at the Iran Statistics Center and Khuzestan Governorate (Fig. 5). The point that makes ecological migration more serious in Khuzestan is the destination of emigrants. Although there is no accurate information on the destination of emigrants in Khuzestan, studies have shown that neighbouring provinces with a temperate climate (Lorestan, Chahar Mahal and Bakhtiari, and Isfahan) are always known as the first destination for Khuzestan climate emigrants. Also, according to the data of Statistics Center of Iran, more than 35% of the rural climatologic migrants are destined for the cities of Khuzestan (Statistics Center of Iran). This has created challenges such as informal settlement, insecurity, and lack of effective access to facilities in the major cities of this province. The recession of the productive rural economy, the abandonment of vast territorial of the border region in Khuzestan and the intensification of unemployment have been the key impacts of climate change in the villages of Khuzestan.

Evacuated villages and climate change

To investigate the impact of climate change indices on rural emigration, the ratio of the number of evacuated villages to total villages in each township was obtained. After that, the obtained number is standardized. The obtained value is a number between zero and 1. The closer number to 1 means the higher rate of evacuated villages.

Table 4. The normalized numbers of evacuated villages to total number of villages in Khuzestan Township

Township	Normalized index of evacuated villages to total number of villages	Median temperature regression	Median of precipitation regression
Andimeshk	.35	-0.08047	-0.41991
Dezful	.27	-0.70585	1.080749
Lali	.29	-0.49554	-0.25929

Township	Normalized index of evacuated villages to total number of villages	Median temperature regression	Median of precipitation regression
Andika	.29	1.35846	0.314358
Gotvand	.28	-1.24822	-1.27808
Shush	.26	0.95999	-2.21886
Shushtar	.22	1.35846	0.314358
Masjed Soleyman	.29	-0.49554	-0.25929
Izeh	.18	-0.93829	1.323975
Dasht-e Azadegan	.61	-0.08047	-0.41991
Hoveyzeh	.59	0.19625	0.098667
Bavi	.22	1.37506	-0.07113
Haftkel	.21	-0.70032	0.41532
Bagh-e Malek	.21	-0.93829	1.323975
Ramhormoz	.19	0.95999	-2.21886
Ahvaz	.09	1.35846	0.314358
Karun	.35	-0.70585	1.080749
Ramshir	.61	-1.24822	-1.27808
Omidiyeh	.38	-1.60795	1.071571
Aghajari	.38	-1.24822	-1.27808
Behbahan	.39	0.59472	0.998144
Hendijan	.49	1.37506	-0.07113
Mahshahr	.59	1.37506	-0.07113
Shadegan	.69	-0.70585	1.080749
Khorramshahr	.68	0.09110	0.328126
Abadan	.63	0.19625	0.098667

Table 5. *The correlation coefficient between evacuated villages with temperature and precipitation*

		P	T
P	Pearson correlation	1	.018
	Sig. (1-tailed)	0	.464
	N	27	27
T	Pearson correlation	.018	1
	Sig. (1-tailed)	.464	
	N	27	27

In conclusion, the printouts indicate that the strength of association between the variables is very high

($r = 1$) for precipitation, and very low ($r = .018$) for temperature. It means that the correlation coefficient is very highly significantly different from zero ($P < 0.001$) for the effects of precipitation on evacuations of villages in Khuzestan province. Nevertheless, the results of correlation test show that there is no significant relationship between evacuation of villages in Khuzestan province and change of temperature. The most important reason is that the climate in the province has been warm and humid. Therefore, the rise in temperature cannot be considered a factor in the displacement and evacuation of villages.

Conclusions

Climate change has resulted in wide-ranging effects on the environment and the socio-economic sectors including water resources, agriculture and food security, human health, terrestrial ecosystems, biodiversity, and coastal zones. Therefore, climate change is an important driving force which influences human beings' habitat almost all over the world with diverse degrees of intensity. However, not all regions and countries as well as provinces have been equally affected by climate change. Iran is a country that has been strongly affected by climate change in recent years due to its geographical location, spatial extent, climate variability, basic economic developments and, of course, demographic changes. Khuzestan province, as a strategic region in southwest of Iran, has experienced these effects more than any other region. Because of high

dependence on agriculture and the elements of natural environment like the land, water resources, fertile soil, rainfall, etc., the rural areas in this province experience the impacts of climate change significantly. The large migration and displacement of populations in rural areas of the province due to these climatic changes can be considered as the most important consequence of climate change in these areas. The findings of research, based on demographic transformations in different periods of the province's census over the course of nearly 20 years, show that the number of vacant villages has risen from 1,217 to 2,398. During the same period, the rural population experienced a rapid negative growth from (-0.02) to (-4.6). Finally, negative rural population growth can be clearly linked with widespread climate change in Khuzestan.

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