



# Journal of Environmental Studies

Vol. 46, No. 4, Winter 2021

Journal Homepage: [www.Jes.ut.ac.ir](http://www.Jes.ut.ac.ir)  
Print ISSN: 1025-8620 Online ISSN 2345-6922

## Drought and Ecological Migration in Northwestern of Iran Over the Last Three Decades

Document Type  
Research Paper

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Received  
October 19, 2020

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Accepted  
January 10, 2021

DOI: [10.22059/JES.2021.323287.1008170](https://doi.org/10.22059/JES.2021.323287.1008170)

### Abstract

Drought is one of the effective factors in ecological migration, especially in arid and semi-arid regions. In this paper, the northwestern of Iran was selected to investigate the relationship between climate drought and internal migration. To this end, the Standard Precipitation Index was used to monitor the drought. SPI values for a period of 30 years were calculated using data from 12 synoptic stations. Then, the study area was zoned using the SPI data in the GIS environment. The Net Migration Rate for the last three decades was also calculated. Geographical Weight Regression in GIS environment was used to investigate the relationship between drought and internal migration. The results of drought monitoring showed that the spatial pattern of drought occurrence generally extends from the southwest to other geographical directions, especially the eastern and northeastern regions of the study area. Analysis of NMR also showed that in the study period, most of the counties in the study area (about 75%) had negative NMR. Finally, the general results of GWR analysis revealed the existence of a relatively low  $R^2$  (21.5%) between the independent and dependent variables.

**Keywords:** Ecological migration, Drought, SPI, Net migration rate, GWR

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**Extended abstract****Introduction**

Permanent or temporary migration has always been one of the most important strategies that adopted by human societies and individuals in the face of ecological or man-made disasters. However, our knowledge about the complex relationship between ecological changes and migration is relatively poor. Migration due to drought and climatic changes is one type of ecological migration. Drought is one of the most important climatic hazards in Iran that is evident in various sectors such as water resources, wetlands, and lakes drying in different parts of the country. Monitoring of drought in the past years, can increase our understanding and awareness about climate changes and would improve insights, predictions, and future planning on drought. Standardized Precipitation Index (SPI) is one of the most well-known and widely used indexes to monitor drought in any scale.

Investigating the relationship between ecological factors and internal migration would be effective in planning and policy making. Iran's internal migration statistics in the last three decades showed that the northwestern counties of Iran almost have a negative net migration rate. Therefore, this paper aims to monitor drought and investigate the relationship between drought and internal migration in northwestern of Iran (Fig.1).

**Materials and Methods**

To achieve the goal of the research, the data and analysis was followed in two sections. In the first section, matrix data of the internal migration in the county level were calculated from Iranian censuses. The net migration rate was estimated for each of the counties in the northwestern region of the country. In the second section of analysis, representative synoptic stations in the study area were selected. In selecting these stations, having 30 years of continuous statistics and appropriate spatial distribution in the study area was considered. Precipitation data of selected stations were obtained from the Meteorological Organization of Iran and were initially processed. Then SPI index was calculated using Meteorological Drought Monitor (MDM) software. After that, the shapefile of the administrative areas of the study area at the county level was taken from the Ministry of Interior of Iran. Then, the values of the Standardized Precipitation Index along with the values of the net migration rate were entered into the GIS environment and attributed to the relevant counties. By using SPI values, the study area was interpolated using Thiessen polygons and Inverse Distance Weighting (IDW). Finally, Thiessen polygons were converted to raster format and then the values of each county were calculated using the majority function of the Zonal Statistics tool.

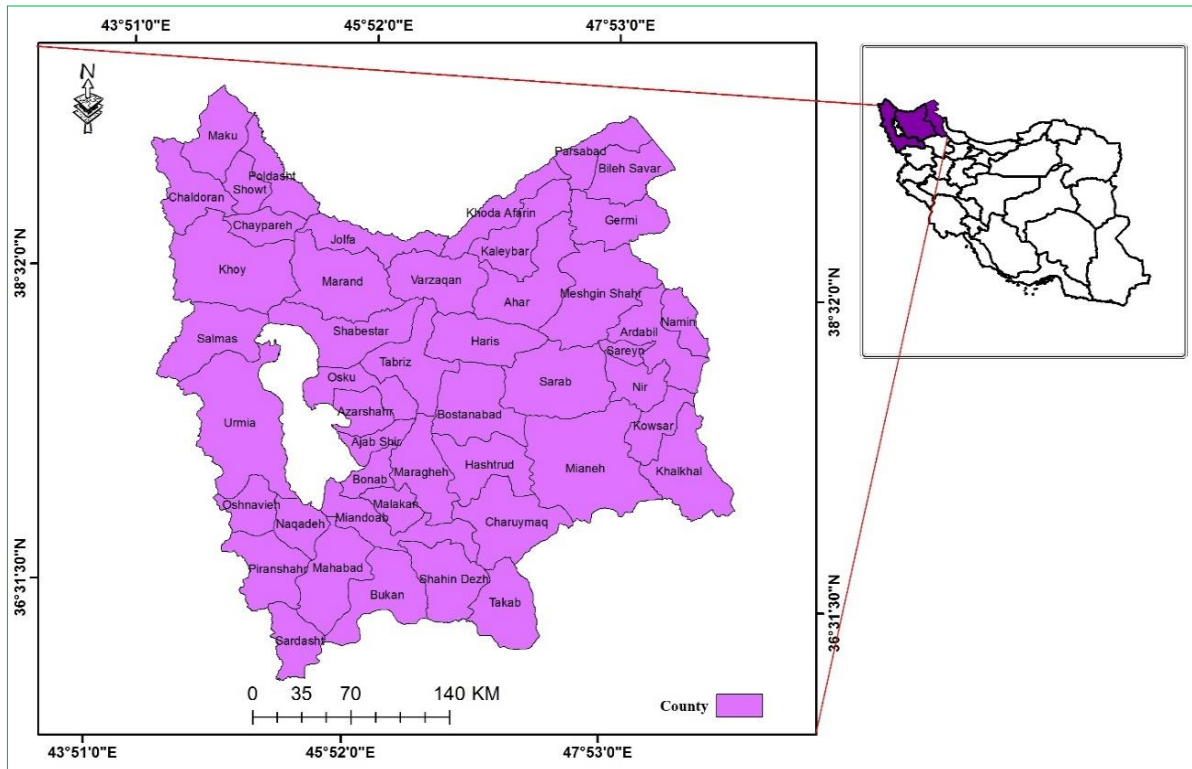
After this phase, spatial analysis techniques were used to investigate the effect of drought on internal migration in the study area. In this regard, the existence of autocorrelation between dependent and independent variables data was investigated using the Moran's I in GIS environment. Since the existence of autocorrelation and clustering pattern was evident in the data, Geographically Weighted Regression (GWR) in GIS environment was used to analyze the relationship between drought and internal migration.

**Discussion of Results****Drought**

Monthly SPI showed that in the past 30 years, the frequency of dry months has been the lowest in the southern areas of Lake Urmia and increased to the central areas, so that the northern part of the region has the highest frequency of dry months. Based on a six-month SPI, the different pattern of drought frequencies was seen in the study area. In this regard, Urmia and Miyaneh synoptic stations had the most drought frequencies.

The one-year SPI also showed that Mahabad station and surrounding areas had the lowest drought frequency (2 years). This station had a similar pattern in the monthly and six-month SPI. Among the

remaining eleven stations, Ardabil, Khoy, Jolfa, and Tabriz have experienced 6 years of drought and Miyaneh, Mako, Parsabad, and Maragheh have experienced 5 years and Khalkhal, Ahar, and Urmia have experienced 4 years. One-year SPI revealed that the pattern of drought distribution extends from the southwest, i.e. Mahabad station, to other geographical directions.



**Fig 1. Location of the study area**

**Migration**

In the last three decades, only 26 percent of the region's counties have had a positive inter-county net migration rate. Thus, less than one-third and 74 percent of study area counties have a negative inter-county net migration rate. The spatial pattern of distribution of counties with a positive net migration rate is mainly concentrated around Lake Urmia, and this spatial pattern is well visible in the last three decades.

**Relationship**

The overall results revealed that there is a relatively low coefficient of determination (average 21.5 percent) between the independent and dependent variables. However, this amount of explanatory is not far from expectation because many variables are influential in decisions leading to migration and this amount of explanatory seems to be significant for the drought variable.

**Conclusion**

Ecological migration is one of the issues that has attracted the attention of various researchers due to the extensive changes in the ecological context that made by humans and sometimes by natural processes. Drought is one of the ecological factors that can cause population movements, especially in arid and semi-arid regions. Although drought is not an unfamiliar phenomenon for arid and semi-arid climates, climate change and excessive use of surface and groundwater resources have intensified its

impact. Migration is affected by many factors and understanding drought as one of the migration causes is very complex. The relationship between drought and migration in the study area indicates a relatively weak relationship. This is primarily due to the nature of migration, which is influenced by various economic, social, cultural, political and environmental factors. Also, drought has several dimensions that in the present study only its climatic dimension has been studied. The SPI revealed that little drought has occurred in the study period. Thus, weak relationship can also be due to the timely distribution of precipitation, as the region has received average precipitation, but this has not happened in the growing season. This adds to the complexity of this relationship. However, the amount obtained  $R^2$  is significant given the nature of the migration.