A Comparison of Vegetative Climate of Artemisia Sieberi Besser and Artemisia Aucheri Boiss in Iran

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Abstract

The relationship between plant species and climatic factors has always been a fundamental issue in plant ecology, and the use of multivariate statistical methods can be effective in revealing the relationship between climatic factors and plant species distribution. Therefore, in this study, climatic factors affecting the distribution of *Artemisia sieberi* and *Artemisia aucheri*, widely distributed in Iran, were investigated. For this purpose, 117 climatic factors were used, and to reduce the number of factors and determine the most important effective ones, a factor analysis was used by principal component analysis. The results showed that six factors including heating temperature, spring and summer precipitation, wind, autumn-winter precipitation, and dusty and cloudiness days explained 37.32%, 22.54%, 7.18%, 6.6%, 4.22%, and 4.15% of data variation, respectively. Together these seven factors account for 82% of data variation. The autumn-winter precipitation and heating temperature had the greatest impact on the presence of *Artemisia sieberi* and *Artemisia aucheri*, respectively, so that the autumn-winter precipitation was negative in areas where *Ar.sieberi* is observed. The heating temperature factor is negative in areas where *Ar.aucheri* is present, while it is positive in areas lacking *Ar.aucheri*. The study of the effect of environmental factors on Artemisia species distribution is very important in planning and management of natural resources, and Artemisia is one of the most important plants in the country's rangelands; therefore, the results of this research can be used for practical planning, management and reclamation of these rangelands.

Introduction

Iranian rangelands with an area of 90 million hectares cover the widest area of the country (about 54%), more than 70% of which are located in arid and semi-arid regions. The general land-use of these lands in the country is rangeland, and overgrazing in these regions has often led to changes in the quantity and quality of vegetation and soil, increasing barren lands, and desertification expansion (Azarnivand et al., 2009). Proper management and exploitation of rangelands requires identifying the characteristics of the key species and determining the factors affecting their distribution (Azarnivand et al., 2003).

A large part of Iran, especially mountainous areas, is covered by shrubs, and areas with this type of vegetation are among the important rangeland (Mozaffarian, 1989). Artemisia L. is the largest genus of the Anthemideae tribe and one of the largest genera in the Asteraceae family. Globally, the number of species of this genus is estimated between 200 to 450 species (Jalili, 2015). In Iran, this genus has 34 known species, which is one of the most significant and important plant species in the flora of Iran in terms of distribution. Different species of this genus in Iran have distributed from the lowest points of the Caspian Sea to altitudes of 4000 meters above sea level. In many areas, some species, including *Artemisia sieberi* and *Artemisia aucheri*, are considered the most important forage plants of rangelands. In addition to the forage value, industrial and pharmaceutical applications of different species have caused them to receive special attention (Rashtian and Karimian., 2014).

According to Azarnivand (2003) and Jafari et al., (2003), *Artemisia sieberi* is considered as the most important species of this genus in Iran because it is the dominant vegetation cover of the Irano-Turanian region and steppe regions in Iran. This species is highly resistant to harsh environmental conditions due to its prominent features and therefore plays an important role in the stability and survival of vegetation. Also *Artemisia aucheri* Boiss is very valuable in arid and semi-arid regions in terms of environmental protection, especially prevention of soil erosion and providing forage for livestock and wildlife (Mozaffarian, 1989).

Extent Habitats of *Artemisia sieberi* and *Artemisia aucheri* and their different characteristics in Iran. It has attracted the attention of various researchers.

Akbar pourYasaghi (1995) studied the ecological characteristics of *A. aucheri* in the Gorgan and Dasht region and concluded that the minimum altitude of the habitat of this species was 900 meters in the Khosh Yilagh region and its maximum altitude was 2700 meters in Chaharbagh region. The highest density of this species was in the altitude range of 2000 meters.

Azarnivand et al., (2003) investigated the effect of soil properties and altitude changes on the distribution of *A. sieberi* and *A. aucheri* in Vardavar, Garmsar, and Semnan rangelands, and after studying vegetation, soil, and topography data from different habitats, they found that organic matter, soil nitrogen, and gypsum, and altitude were the most important factors influencing the distribution of these two species in the study areas.

Climate is a general condition of the prevailing weather conditions of a particular place based on long-term statistics (Bailey. Robert, 1991). There are different methods for climate zoning, most of which are based on temperature and rainfall, but sometimes zoning is based on important non-climatic factors such as vegetation. Vegetation plays an important role in climatic zoning. In fact, it can be used as a set of different climatic and topographic patterns; therefore, it is possible to use the adaptation of vegetation and climate maps to identify bioclimatic zones (Chamberlain and Matthews, 1970). In recent years, valuable studies have been conducted on vegetative climate and zoning, which can be referred to the studies of Saboohi and Barani (2015), Khodagholi et al. (2015), Saboohi and Khodagholi (2013), Pakzad et al. 1392), Fatemi et al. (2012), Lashni et al. (2011), Taste et al., (2008), and Khodagholi et al. (2007). In a study conducted by Saboohi and Barani (2016), the cooling-humidity temperature, rain-thunder, cloudiness, and wind were reported as the factors affecting the distribution of *Astragalus gossypinus* in Isfahan province, respectively accounting for 39.05%, 32.77%, 11.44%, and 8.63 % (totally 91.88%) of variation in initial variables of Isfahan's vegetative climate. Khodagholi et al. (2015) studied the climatic characteristics of *Quercus brantii* in Chaharmahal and Bakhtiari province. The results showed that precipitation, heating temperature, and wind, with 28.79%, 20.13%, and 4.71%, respectively, were the three factors affecting the distribution of this species. For climatic zoning of Sistan and Baluchestan province, Saliqeh et al. (2008) used 20 climatic variables, and with the methods of factor analysis and climatic clustering of the province came to the conclusion that the climate of the province is made up of five factors including rainfall, temperature, radiation, wind, and thunder. Globally, Pineda-Martinez et al. (2007) zoned the bioclimatic regions of central and northeastern Mexico using factor analysis. Zhou et al. (2009) zoned the East Murrumbidgee Irrigation Area (MIA) using factor analysis and clustering. They used long-term climate data to study climate variability. The results show two classifications. Yunus (2011) used factor analysis and clustering method for Malaysian bioclimatic classification, and the results showed a very good effect of these methods on this classification.

Since Artemisia rangelands are affected by destructive human activities and livestock grazing, they are among the ecosystems that need to be conserved. Therefore, the first step to prevent degradation is to identify vegetation and studying plant communities and the factors affecting them. Using this information, proper management methods to maintain and improve these important rangelands of the country are reviewed, and correct conservation decisions are made. For this purpose, the climatic characteristics of *A. sieberi* and *A. aucheri* were investigated.

The study area

Iran with an area of 1.648 000 square kilometers is located between latitudes 25° 3' to 39 ° 47' N, and longitudes 44° 5' to 63° 18' E in southwest Asia (Razei et al., 2005). Therefore, in terms of latitude, its southern parts are located in the tropics, and its northern parts are in the subtropical regions. Iran has different climates due to the 15-degree difference in latitude between southernmost and northernmost points and also due to the topography and elevations.

Regardless of these two factors, air masses colliding with each other from different lands on the plateau of Iran are considered as important determinants of Iran's climate. Adjacent to the Sea of Oman and the Persian Gulf on the one hand and the influence of the Mediterranean Sea on the other hand, the arid desert of Saudi Arabia and Africa, and the Great Siberian Plain in the northeast are profoundly effective in the type of air masses reaching Iran (Alizadeh et al., 2012). As a result, Iran has special characteristics geographically and possesses a very variable climate. Iran is a relatively high land so that its average altitude is more than 1000 meters above sea level (Faraji., 2005).

The average annual precipitation of the whole country is about 252 mm, and the maximum amount in the Caspian Sea and the sloping areas of the Alborz and Zagros mountains is 1800 and 400 mm, respectively. Moving towards the interior areas in the center and east, the amount of precipitation even reaches less than 100 mm per year, depending on the location (Alizadeh et al., 2012).

Materials And Methods

The totality of the climate of each place is achieved through the use of all climatic elements. Therefore, the data of 117 climatic variables in 164 synoptic meteorological stations of the country (Fig. 1) were selected in monthly and annual intervals (Table 1).

It seems that these climatic elements have been effective in the climatic systematization and formation of the region, and directly and indirectly affect the growth of *Ar. sieberi* and *Ar. aucheri* in a way that can reflect the acclimation of this species in its habitat. Then a matrix of 164 × 117 (stations on rows and variables on columns) was formed. The kriging geostatistical method was used to convert station point data to spatial data. The kriging estimator is one of the most important unbiased linear estimators because, firstly, it is without systematic error (Davis, 1986) and secondly, its estimation variance is minimal; therefor, the Kriging method was used in this study. This feature can increase the matching of the maps extracted from factor analysis and vegetation areas of these species in studying the plant species of natural areas. The point data matrix was converted to a spatial data matrix with dimensions of 1267 *1167 using Surfer Ver14 software during the kriging interpolation process. This matrix covered the whole of Iran and was used as the input of principal component analysis. The principal component analysis, with the Varimax rotation, was used to reduce the number of factors and study the acclimation of *Ar. sieberi* and *Ar. aucheri*. The factor load matrix and the factor score matrix were obtained using principal component analysis. The factor load matrix obtained from the principal components analysis on climatic variables determined the effects of each component on them, and the factor score matrix was used to map the factors in Surfer software. Then, the vegetation type map of *Ar. sieberi* and *Ar. aucheri* was prepared on a scale of 1:250,000 by field observations and recording the species points using GPS and GIS software. To record the points by GPS, the pixel size of 36 × 36 square kilometers was used, so that the range of each pixel was determined and the coordinates of 40 points containing these species were taken by GPS. The accuracy of the vegetation map was confirmed by the Research Institute of Forests and Rangelands. Then, the map of factors was adapted to the vegetation map, and the mean factors extracted from factor analysis in the distribution areas of different types of these species were determined.

Table 1
Climatic elements affecting the growth of *Ar. sieberi* and *Ar. aucheri*

Sign element	Climatic element	Sign element	Climatic element	Sign element	Climatic element
V89	March average wind speed	V46	Average annual relative humidity	V1	Mean minimum temperature in January
V90	April average wind speed	V47	Maximum relative humidity in March	V2	Mean minimum temperature in February
V91	May average wind speed	V48	Maximum relative humidity in April	V3	Mean minimum temperature in March
V92	Jun average wind speed	V49	Maximum relative humidity in May	V4	Mean minimum temperature in October
V93	Jul average wind speed	V50	Maximum relative humidity in Jun	V5	Mean minimum temperature in November
V94	August average wind speed	V51	Maximum relative humidity in September	V6	Mean minimum temperature in December
V95	September average wind speed	V52	Maximum relative humidity in October	V7	Mean minimum of annual
V96	October average wind speed	V53	Maximum annual relative humidity	V8	Days with a minimum temperature of 4 degrees Celsius and lower January
V97	November average wind speed	V54	Minimum relative humidity in March	V9	Days with a minimum temperature of 4 degrees Celsius and lower February
V98	December average wind speed	V55	Minimum relative humidity in April	V10	Days with a minimum temperature of 4 degrees Celsius and lower December
V99	Annual average wind speed	V56	Minimum relative humidity in May	V11	Days with a minimum temperature of 4 degrees Celsius and lower annual
V100	January cloudy days	V57	Minimum relative humidity in Jun	V12	Number of January frost days
V101	February cloudy days	V58	Minimum relative humidity in September	V13	Number of February frost days
V102	March cloudy days	V59	Minimum relative humidity in October	V14	Number of December frost days
V103	April cloudy days	V60	Minimum annual relative humidity	V15	Number of annual frost days
V104	December cloudy days	V61	The amount of precipitation in January	V16	Absolute minimum annual temperature
V105	Annual cloudy days	V62	The amount of precipitation in February	V17	Average maximum temperature in March
V106	March Sunshine	V63	The amount of precipitation in March	V18	Average maximum temperature in April
V107	April Sunshine	V64	The amount of precipitation in April	V19	Average maximum temperature in May
V108	May Sunshine	V65	The amount of precipitation in May	V20	Average maximum temperature in Jun

Sign element	Climatic element	Sign element	Climatic element	Sign element	Climatic element
V109	Jun Sunshine	V66	The amount of precipitation in Jun	V21	Average maximum temperature in July
V110	Jul Sunshine	V67	The amount of precipitation in July	V22	Average maximum temperature in August
V111	August Sunshine	V68	The amount of precipitation in August	V23	Average maximum temperature in September
V112	September Sunshine	V69	The amount of precipitation in September	V24	Average maximum temperature in October
V113	October Sunshine	V70	The amount of precipitation in October	V25	Average annual maximum temperature
V114	Annual Sunshine	V71	The amount of precipitation in November	V26	Absolute maximum annual temperature
V115	Winter precipitation	V72	The amount of precipitation in December	V27	January average temperature
V116	Spring Precipitation	V73	The amount of precipitation in Jun	V28	February average temperature
V117	Summer precipitation	V74	The amount of annual precipitation	V29	March average temperature
		V75	Number of days with thunderstorm in March	V30	April average temperature
		V76	Number of days with thunderstorm in April	V31	May average temperature
		V77	Number of days with thunderstorm in May	V32	July average temperature
		V78	Number of days with thunderstorm in Jun	V33	August average temperature
		V79	Number of days with thunderstorm in October	V34	September average temperature
		V80	Number of days with thunderstorm annual	V35	October average temperature
		V81	Number of dusty days in April	V36	November average temperature
		V82	Number of dusty days in May	V37	December average temperature
		V83	Number of dusty days in Jun	V38	Annual average temperature
		V84	Number of dusty days in July	V39	Average relative humidity in March
		V85	Number of dusty days in August	V40	Average relative humidity in April
		V45	Number of dusty days in September	V41	Average relative humidity in May

Sign element	Climatic element	Sign element	Climatic element	Sign element	Climatic element
		V86	Number of annual dusty days	V42	Average relative humidity in Jun
		V87	January average wind speed	V43	Average relative humidity in September
		V88	February average wind speed	V44	Average relative humidity in October

Results

Applying a factor analysis using the principal component method and with varimax rotation showed that more than 82% of the data variance can be explained by seven factors.

The contribution of the first factor was 37.32%, the second factor was 22.54%, the third factor was 7.18%, the fourth factor was 6.6%, the fifth factor was 4.22%, and the sixth factor was 4.15% percent, and the contribution of the Eigen variance of the seventh factor was less than 1. In fact, its value was less than the value of the original variables, so they were removed from later analyzes.

Therefore, it can be said that the overall climate of the study area is affected by six factors.

Table 2 shows the degree of importance of each of these factors.

Table 2
Relative importance of factors

Factors	1	2	3	4	5	6
Eigen values	50.35	30.43	9.69	8.92	5.70	5.61
Relative variance percentage	37.32	22.54	7.18	6.61	4.22	4.15
Cumulative relative variance	37.32	59.86	67.04	73.65	77.88	82.03

Since the purpose of factor analysis is to reduce the number of variables and convert it into several new factors, so after calculating the factor load, it was determined that a set of climatic elements including mean minimum temperature (Jan, Feb, Mar, Oct, Nov, Dec, annual), days with a minimum temperature of 4 degrees Celsius and lower (Jan, Feb, Dec, annual), number of frost day (Jan, Feb, Dec and annual), absolute minimum temperature (Annual), mean maximum temperature (Mar, April, May, Jun, Jul, Aug, Sep, Oct and annual), absolute minimum temperature (annual), mean temperature (Jan, Feb, Mar, Apr, May, Jun, Jul, Sep, Oct, Nov, Dec and annual) constituted the first factor. Moreover, since temperature factors with a positive correlation were in this group, the first factor can be called the heating temperature factor.

The second factor was the spring and summer precipitation, because the factor loads of a set of climatic variables including relative humidity (Mar, Apr, May, Jun, Sep, Oct and annual), maximum relative humidity (Mar, Apr, May, Jun, Sep, Oct and annual), minimum relative humidity (Mar, Apr, Jun, Sep, Oct and annual), amount of precipitation (May, Jun, Jul, Aug, Sep, Oct), spring precipitation and summer precipitation had the most weight on these factors.

The third factor includes the average wind speed (January, February, March, April, May, June, July, August, September, October, November, December, annual) with a positive correlation, which was named as the wind factor.

The fourth factor was introduced as the autumn-winter precipitation factor, because the factor loads of the total climatic elements of precipitation (January, February, March, April, May, November, December, and annual), winter precipitation, and autumn precipitation had the highest weight.

The fifth factor was named dusty days because the dusty-days element (April, May, June, July, August, September, and annual) is in this group with a positive correlation.

The sixth factor includes the number of cloudy days (January, February, March, April, December, and annual) and sunny hours (March, April, May, June, July, August, September, October, and annual). This factor was named cloudiness since the cloudy days and the sunny hours are in this group with a positive and negative correlation, respectively (Table 3).

Table 3
Factor loads of 135 climatic elements in Iran

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
V1	**0.96**							V69		**0.52**					
V2	**0.97**							V70		**0.54**					
V3	**0.96**							V71				**0.71**			
V4	**0.97**							V72				**0.91**			
V5	**0.97**							V73				**0.77**			
V6	**0.96**							V74							**0.54**
V7	**0.98**							V75							**0.58**
V8	**0.93-**							V76							**0.66**
V9	**0.88-**							V77							**0.71**
V10	**-0.90**							V78							**0.65**
V11	**-0.90**							V79							**0.80**
V12	**-0.96**							V80					**0.79**		
V13	**-0.95**							V81					**0.78**		
V14	**-0.96**							V82					**0.78**		
V15	**-0.96**							V83					**0.79**		
V16	**0.91**							V84					**0.82**		
V17	**0.89**							V85					**0.84**		
V18	**0.87**							V86					**0.79**		
V19	**0.87**							V87			**0.95**				
V20	**0.81**							V88			**0.96**				
V21	**0.73**							V89			**0.95**				
V22	**0.75**							V90			**0.91**				
V23	**0.84**							V91			**0.79**				
V24	**0.91**							V92			**0.56**				
V25	**0.88**							V93			**0.44**				
V26	**0.68**							V94			**0.48**				
V27	**0.95**							V95			**0.67**				
V28	**0.95**							V96			**0.87**				
V29	**0.93**							V97			**0.97**				
V30	**0.92**							V98			**0.95**				
V31	**0.92**							V99			**0.85**				
V32	**0.90**							V100						**0.52**	

V33	**0.87**							V101						**0.47**	
V34	**0.90**							V102						**0.52**	
V35	**0.95**							V103						**0.55**	
V36	**0.97**							V104						**0.55**	
V37	**0.97**							V105						**0.50**	
V38	**0.95**							V106						**-0.54**	
V39	**0.96**							V107						**-0.57**	
V40		**0.87**						V108						**-0.55**	
V41		**0.88**						V109						**-0.59**	
V42		**0.93**						V110						**-0.57**	
V43		**0.96**						V111						**-0.66**	
V44		**0.96**						V112						**-0.76**	
V45		**0.96**						V113						**-0.62**	
V46		**0.96**						V114						**-0.70**	
V47		**0.77**						V115				**0.94**			
V48		**0.80**						V116		**0.52**					
V49		**0.87**						V117		**0.57**					
V50		**0.96**													
V51		**0.96**													
V52		**0.94**													
V53		**0.92**													
V54		**0.91**													
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V56		**0.94**													
V57		**0.93**													
V58		**0.92**													
V59		**0.94**													
V60		**0.96**													
V61				**0.92**											
V62				**0.92**											
V63				**0.87**											
V64				**0.60**											
V65		**0.54**													

V66		**0.65**													
V67		**0.64**													
V68		**0.58**													

Figure 2 shows the spatial variations of the heating temperature factor. As is clear, the lowest and highest value of this factor is -1.6 and 2, which is observed in the northwestern region and southern regions of Bandar Abbas, respectively. As shown in this figure, moving from the western to southern regions, the amount of heating temperature increases and reaches the maximum value of this factor in the southern region, especially around Bandar Abbas. The presence of heights in the western regions of Iran reduces the temperature in these regions; however, the southern regions of Iran have the lowest altitude, and we can see the highest temperature.

The lowest score of spring and summer precipitation is -1, related to the central parts to the southeast, and the highest value is equal to 3.2, which is in the northern part of the country. Therefore, the northern regions had more spring and summer precipitation and relative humidity, while the least amount of spring and summer humidity and precipitation was observed in the central and southeastern parts of the province (Fig. 4).

Figure 5 shows the spatial variation of the third factor, wind, in the study area. The lowest score of this factor is -1.4 in all of Iran, except the eastern and southeastern regions, and the highest value is equal to 2.2, observed in all of Iran in a scattered manner.

Figure 6 shows the spatial variation of the autumn-winter precipitation. The lowest value of this factor is -1.5, observed in the northwest corner, and the highest value is equal to 9 in the eastern part near Shahrekord.

The fifth factor is called dusty days, the highest value of which is observed near Zabol with a score of 9, and the lowest value is near Kerman and Yazd (Fig. 7). The lowest score of cloudiness factor is -1.8, related to the southern part of the country, and the highest value is 2.2, observed in the northern part of the country (Fig. 8).

Climatic characteristics of *Artemisia sieberi* and *Artemisia aucheri*

To determine the distribution of *Artemisia sieberi* and *Artemisia aucheri*, the habitats of these two species were determined using the vegetation map prepared by the Research Institute of Forests and Rangelands and field visits (Fig. 9).

Then the vegetation map was digitized, and to investigate the effect of climatic elements on the distrbution of these two species, the factor score matrix was used. The vegetation map (Fig. 9) was adjusted with the map of variables and factor scores, the scores of each cell with these species were determined.

According to the extracted scores, the average scores of the six factors were determined and the results were listed in Table 4.

Habitats of Artemisia sieberi

The habitat area of this species in Iran is 345988.95 square kilometers (20.99%), and this species is observed in all regions except the western half of the country.

Table 4 shows the factor scores of the seven main factors in the distribution range of this species. The scores of heating temperature, spring and summer precipitation, wind, autumn-winter precipitation, dusty and cloudy days in these areas were calculated to be -0.21, -0.19, 0.33, -0.41, -0.4 and0.01, respectively.

Some climatic characteristics of Artemisia sieberi habitats are: the average annual precipitation is 158.66 mm, the average annual temperature is 17.71 ° C, the average number of frost days is 56.50, the average wind speed is 5.46 knots (Table 5), and the average altitude of the areas that include this species is about 1504 meters.

Habitats of Artemisia aucheri

The habitat area of *Artemisia aucheri* is about 145679.55 km2, which occupies about 8.83% of the country's area. Table 4 shows the average factor scores for the areas where *Artemisia aucheri* is a companion species. The scores of heating temperature, spring and summer precipitation, wind, autumn-winter precipitation, dusty and cloudy days in these areas were calculated to be -0.68, 0.38, 0.003, -0.12, -0.18, and 0.02, respectively.

Some climatic characteristics of these areas are: the average annual precipitation is 255 mm, the average annual temperature is 15.27 ° C, average number of frost days is 77, the average wind speed is 5.16 knots (Table 5), and the average altitiude of the areas that include this species is about 1966 meters.

Table 4
–Mean factor scores in different regions of *Artemisia sieberi* and *Aetemisia aucheri*

Species name	Heating temperature	Spring and summer precipitation	Wind	Autumn and winter precipitation	Dusty days	cloudiness	Mean height (m)
Ar.si	-0.21	-0.19	0.33	-0.41	-0.40	0.01	1503.95
Ar.au	-0.68	0.38	0.003	-0.12	-0.18	-0.02	1966

Table 5
Mean of climatic variables in different regions of *Artemisia sieberi and Aetemisia aucheri*

Climatic element	***Ar.si***	***Ar.au***	**Climatic element**	***Ar.si***	***Ar.au***
Mean minimum temperature in January	-0.70	-2.61	The amount of precipitation in January	27.39	36.47
Mean minimum temperature in February	1.69	-0.47	The amount of precipitation in February	22.18	34.65
Mean minimum temperature in March	5.81	3.52	The amount of precipitation in March	29.19	44.45
Mean minimum temperature in October	11.36	8.87	The amount of precipitation in April	20.72	33.97
Mean minimum temperature in November	5.34	3.47	The amount of precipitation in May	11.29	18.68
Mean minimum temperature in December	1.15	-0.47	The amount of precipitation in Jun	3.46	6.04
Mean minimum of annual	10.83	8.50	The amount of precipitation in July	2.44	4.45
Days with a minimum temperature of 4 degrees Celsius and lower January	8.82	11.69	The amount of precipitation in August	1.68	4.04
Days with a minimum temperature of 4 degrees Celsius and lower February	4.56	7.13	The amount of precipitation in September	1.37	6.33
Days with a minimum temperature of 4 degrees Celsius and lower December	5.46	7.46	The amount of precipitation in October	4.55	13.19
Days with a minimum temperature of 4 degrees Celsius and lower annual	21.68	31.24	The amount of precipitation in November	11.08	22.58
Number of January frost days	18.26	21.01	The amount of precipitation in December	23.19	33.19
Number of February frost days	11.97	15.23	The amount of precipitation in Jun	158.66	254.85
Number of December frost days	14.31	17.06	Number of days with thunderstorm in March	0.71	0.85
Number of annual frost days	56.50	72.70	Number of days with thunderstorm in April	1.49	1.93
Average maximum temperature in March	18.75	15.82	Number of days with thunderstorm in May	2.09	2.84
Average maximum temperature in April	24.43	21.64	Number of days with thunderstorm in Jun	1.06	1.44
Average maximum temperature in May	30.05	27.27	Number of days with thunderstorm in October	0.59	0.71
Average maximum temperature in Jun	35.10	32.35	Number of days with thunderstorm annual	8.49	10.93
Average maximum temperature in July	36.97	34.38	Number of dusty days in April	2.57	1.82
Average maximum temperature in August	35.92	33.59	Number of dusty days in May	3.04	2.25
Average maximum temperature in September	32.29	29.93	Number of dusty days in Jun	2.47	2.21

Climatic element	*Ar.si*	*Ar.au*	Climatic element	*Ar.si*	*Ar.au*
Average maximum temperature in October	26.37	23.99	Number of dusty days in July	2.84	2.62
Average annual maximum temperature	24.80	22.11	Number of dusty days in August	1.77	1.83
January average temperature	4.88	2.66	Number of dusty days in September	1.31	1.37
February average temperature	7.68	5.12	Number of annual dusty days	20.65	16.76
March average temperature	12.21	9.64	January average wind speed	4.18	3.90
April average temperature	17.55	14.97	February average wind speed	5.45	4.92
May average temperature	22.63	19.97	March average wind speed	6.15	5.66
July average temperature	27.34	24.61	April average wind speed	6.29	5.77
August average temperature	29.62	26.98	May average wind speed	6.24	5.79
September average temperature	28.29	25.91	Jun average wind speed	6.39	6.23
October average temperature	24.39	21.91	Jul average wind speed	6.95	6.83
November average temperature	18.82	16.43	August average wind speed	6.38	6.24
December average temperature	12	9.97	September average wind speed	5.32	5.15
Annual average temperature	6.99	5.09	October average wind speed	4.36	4.15
January average temperature	17.71	15.1	November average wind speed	3.94	3.68
Average relative humidity in March	44.13	53.67	December average wind speed	3.80	3.55
Average relative humidity in April	39.65	49.06	Annual average wind speed	5.46	5.16
Average relative humidity in May	32.76	40.92	January cloudy days	5.85	7.10
Average relative humidity in Jun	27	33.09	February cloudy days	4.81	6.66
Average relative humidity in September	28.79	34.24	March cloudy days	6.07	7.99
Average relative humidity in October	35.41	41.93	April cloudy days	5.41	6.79
Average annual relative humidity	38.84	45.83	December cloudy days	5.10	6.37
Maximum relative humidity in March	64.25	74.12	Annual cloudy days	35.03	46.59
Maximum relative humidity in April	59.63	70.58	March Sunshine	229.72	206.80
Maximum relative humidity in May	50.02	60.76	April Sunshine	246.39	229.53
Maximum relative humidity in Jun	41.10	49.85	May Sunshine	304.85	293.22
Maximum relative humidity in September	43.47	51.59	Jun Sunshine	334.84	329.02
Maximum relative humidity in October	56.22	64.54	Jul Sunshine	335.93	336.33
Minimum relative humidity in March	28.65	36.23	August Sunshine	336.25	334.01

Climatic element	*Ar.si*	*Ar.au*	Climatic element	*Ar.si*	*Ar.au*
Minimum relative humidity in April	25.16	32.03	September Sunshine	304.98	297.98
Minimum relative humidity in May	20.87	26.43	October Sunshine	277.77	264.58
Minimum relative humidity in Jun	17.38	21.33	Annual Sunshine	3190.66	3033.35
Minimum relative humidity in September	18.44	21.24	Winter precipitation	78.76	115.58
Minimum relative humidity in October	23.06	26.84	Spring Precipitation	35.48	58.69
Minimum annual relative humidity	26.25	31.46	Summer precipitation	5.49	14.82

Discussion

The type of climate is one of the most influential factors on the life of a region; thus, the distribution of plants and animals is closely related to the climatic conditions of each region. Therefore, knowing the type of climate of a region and the dominant elements that determine the climate of that region can help planners to gain a correct understanding of the climatic conditions of the region to carry out macro projects (Shirani et al., 2009).

In this study, the habitats of two important species, distributed widely in the rangelands of Iran, were selected. Therefore, 117 climatic variables, which were more important in the growth of *Artemisia aucheri* and *Artemisia sieberi*, were used, and the number of variables was reduced from 117 to six by factor analysis.

These six factors accounted for about 82% of the data variance, and in order of importance were heating temperature (37.32 %), spring and summer precipitation (22.54 %), wind (7.18%), autumn-winter precipitation (6.61%), dusty days (4.22%), and cloudiness days (4.15%), respectively. In many studies conducted by ***, temperature, precipitation, and wind were the most important climatic factors. Hessel and et al (2003) showed that precipitation, temperature, wind speed, evaporation potential, and sunshine hours accounted for about 97% of the variance of the initial variables and separated the different regions of Ireland and Britain. Differences in other influential variables, except precipitation and temperature, can be due to several reasons, one of which is the number and type of input variables, and the other is the time intervals that can affect the amount of variance of the data.

Comparison of factor scores in *Artemisia sieberi* and *Artemisia aucheri* habitats showed that although the heating temperature factor was negative in both habitats, *Artemisia sieberi* habitats got a higher score for temperature as compared with *Artemisia aucheri*. Actually, *Artemisia sieberi* is distributed in warmer habitats. Attention to the average height (altitude) and annual temperature of these two habitats confirms this view, so that the average height of *Artemisia sieberi* habitat is 1503 meters, while it is equivalent to 1966 meters for *Artemisia aucheri*. Also, the average temperature in the habitats of *Artemisia sieberi* is equal to 17.71°C, and it decreases to about 15.5°C in the habitats of *Artemisia aucheri*.

For the second factor (summer spring precipitation), the difference between the two habitats is quite noticeable; while the habitat score of *Artemisia sieberi* is negative, it is positive for *Artemisia aucheri*, which indicates that *Artemisia aucheri* needs more moisture than *Artemisia sieberi*.

The score of the third factor in *Artemisia sieberi* habitats is higher than that of *Artemisia aucheri* habitats. It seems that *Artemisia sieberi* habitats are located in lowland areas with higher temperatures, which may be due to the fact that *Artemisia sieberi* habitats are formed in the lowlands and along the central desert and other scattered deserts in central Iran. Besides, the significant difference between the daily and night temperature, as well as the absence of trees and low natural vegetation cover, have provided the conditions for the wind to blow.

Considering that this research was conducted in Iran and especially in the northern regions of the country, which have a precipitation of more than 1500 mm, it makes sense for these two species to receive low score from the forth factor (autumn winter precipitation); however, again, a lower score was obtained for *Artemisia sieberi* than *Artemisia aucheri*. The annual precipitation in the habitats of *Artemisia sieberi* and *Artemisia aucheri* is equal to 159 and 255, respectively. Therefore, *Artemisia aucheri* has a higher moisture requirement.

The habitats of the two species received a negative score for the fifth factor, which indicates that the habitats of these two species were distributed in areas with clear weather.

Although the sixth factor explain small changes, both species get scores around zero.

In general, the comparison of the most important climatic factors affecting the habitat of *Artemisia sieberi* showed that heating temperature, spring and summer precipitation, autumn-winter precipitation, and dusty days were negative in the areas that include this species. However, wind and cloudiness were positively effective in the habitat of this species.

For *Artemisia aucheri*, heating temperature, autumn-winter precipitation, dusty and cloudy days were negative in the areas that include this species. Therefore, the amount of spring and summer precipitation, which is the precipitation of the growing season, can affect the production of *Ar.sieberi*.

Ehsani et al. (2007) showed that the growing season precipitation plus the previous one as a variable in production played a major role, and there was a linear relationship between the growing season precipitation plus the previous one with production.

According to Hanson et al. (1982), moisture from the previous precipitation and the beginning of the growing season remained in the soil as stored moisture, and perennials and shrubs use the moisture stored in the growing season due to their deep roots.

In general, the autumn-winter precipitation factor had the highest effect on the presence of *Ar.sieberi*, so that this factor was negative in the areas where the species was present and showed a significant difference with areas lacking this species; thus, this species can grow in areas with low precipitation.

The heating temperature factor had the highest effect on the presence of *Ar.aucheri*, so that the amount of this factor was negative, indicating that this species prefers cold regions. Since *Ar.sieberi* grows in the plains and *Ar.aucheri* in the highlands, the heating temperature has a negative effect on *Ar.aucheri*. Therefore, the relatively high areas are the habitats of this plant. Hosseini et al. (2013) also reported altitude and climatic conditions as factors affecting the presence of *A.aucheri.* Zare Chahouki (2001), in the study of the distribution of vegetation types of Poshtkouh rangelands of Yazd province, concluded that *A. aucheri* was distributed from an altitude of 2400 meters and above on relatively sloping lands. Azarnivand et al. (2003) studied the growth characteristics of Ar.sieberi and Ar.aucheri in the rangelands of Vardavard, Garmsar, and Semnan, and the altitude above sea level was found effective in the establishment of these two species. The comparison between *Ar.sieberi* and *Ar.aucheri* showed that the amount of spring and summer precipitation and the cloudiness factor had an opposite effect in both species. *Ar. sieberi* is a thermophilic species distributed in the lowlands, indicating the positive effect of the cloudiness factor, while *Ar. Aucheri* is distributed at high altitudes and prefers sunny hours. Also, *Ar.sieberi* species is more resistant to low precipitation during the growing season than *Ar.aucheri*, indicating the positive effect of spring and summer precipitation. Artemisia species and the study of the effect of environmental factors on their distribution are of great importance in the planning and management of natural resource areas. Moreover, Artemisia is one of the most important plants in the country's rangelands. Hence, the results of this study can be applied to planning for the conservation, management, and reclamation of rangelands.

However, the relationship between plants and environmental factors is very complex and delicate, the study of which requires long-term and complete studies. Given the importance of these rangelands, proper and planned management is essential in these areas.

Declarations

Ethical Approval

- The manuscript has not been submitted to more than one journal for simultaneous consideration.
- The submitted work is original and has not been published elsewhere in any form or language
- A single study is not split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time

Consent to Participate

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Morteza Khodagholi, Razieh Saboohi and Ehsan zandi Esfahani. The first draft of the manuscript was written by Morteza Khodagholi and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Consent to Publish

All authors agree with the publication of an article in the Journal of Climatic Change.

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Availability of data and materials

All data and data analysis are available.

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Figures

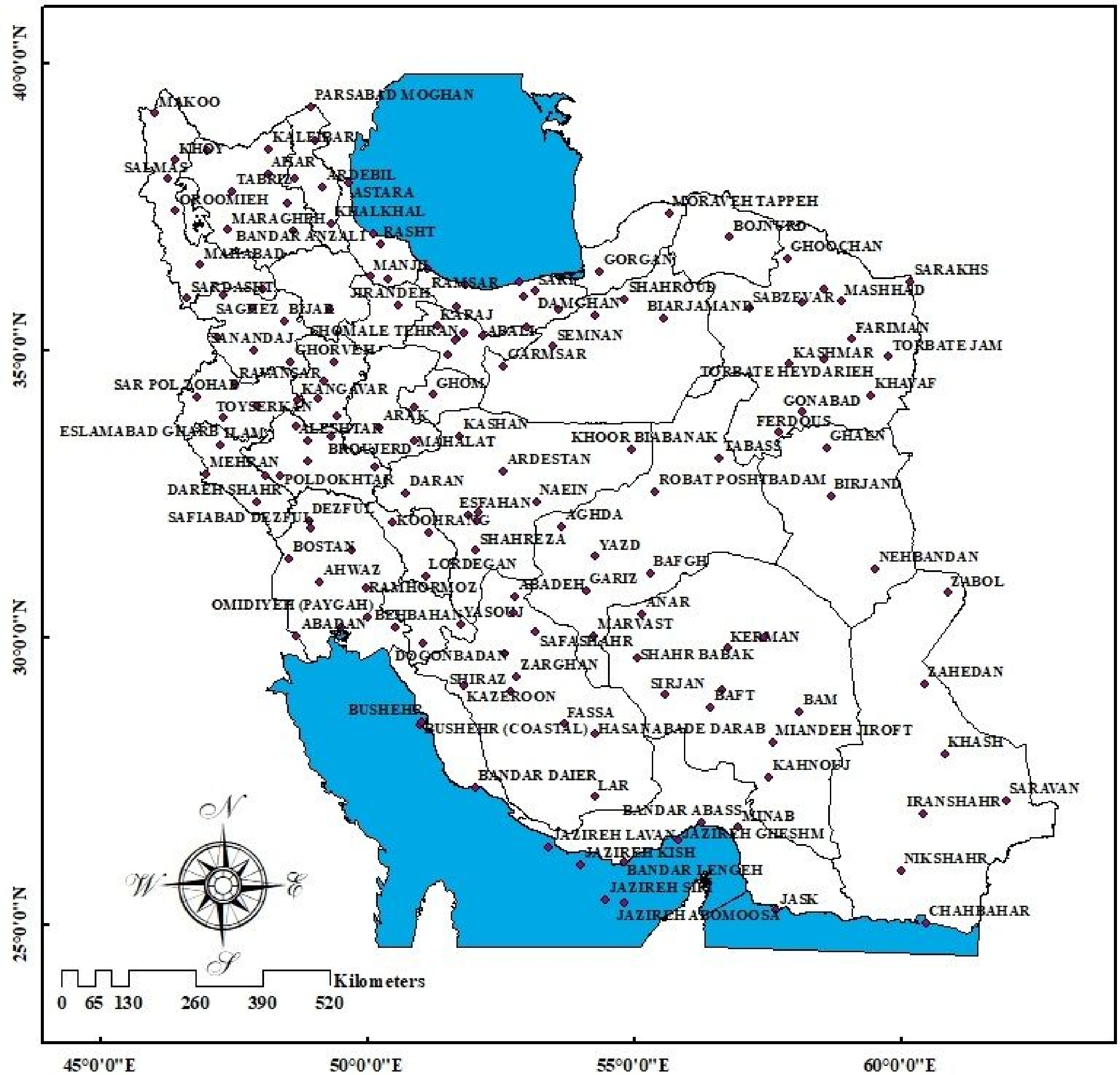

Figure 1

Location of selected meteorological stations in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

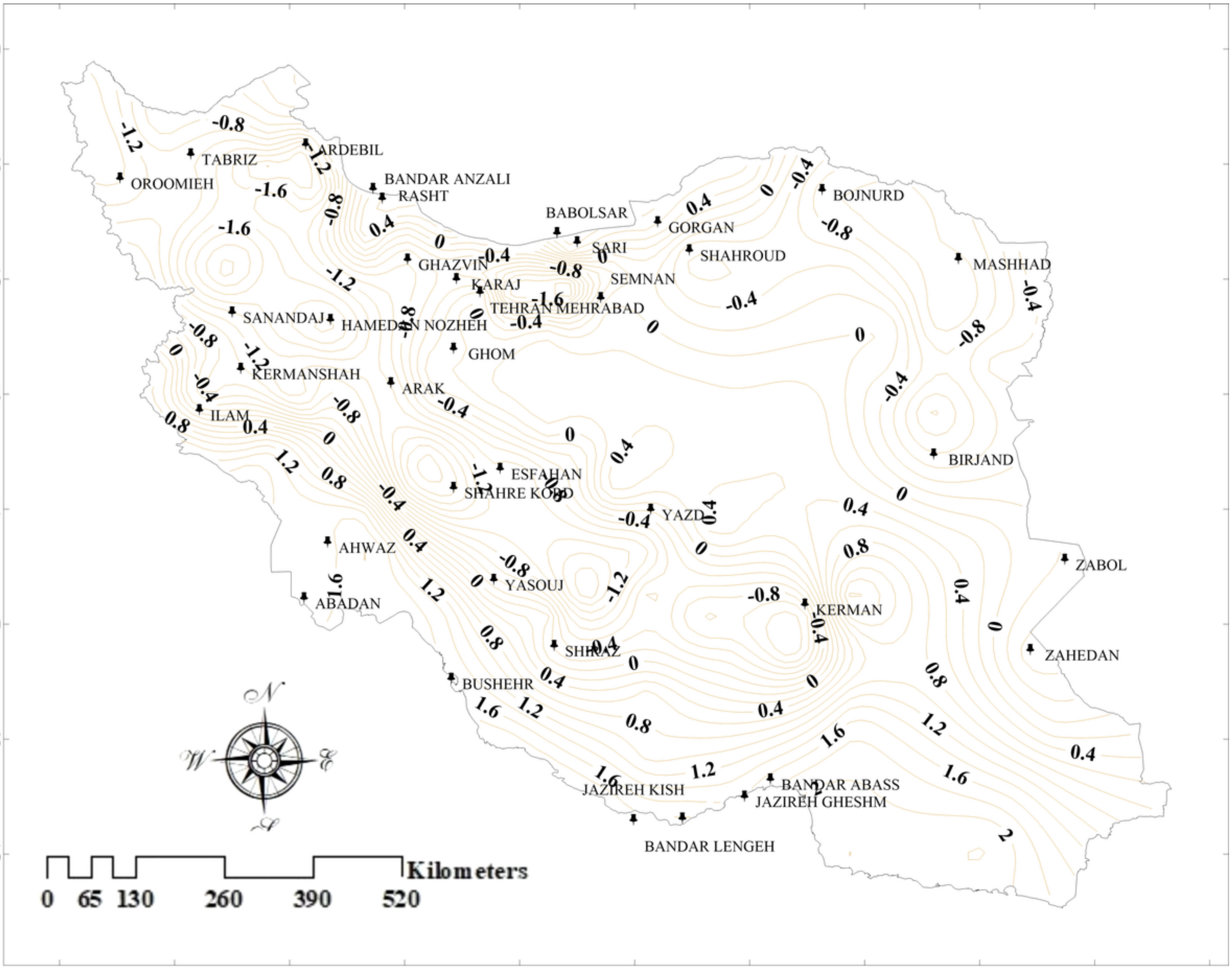

Figure 2

Distribution map of cooling-humidity temperature factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

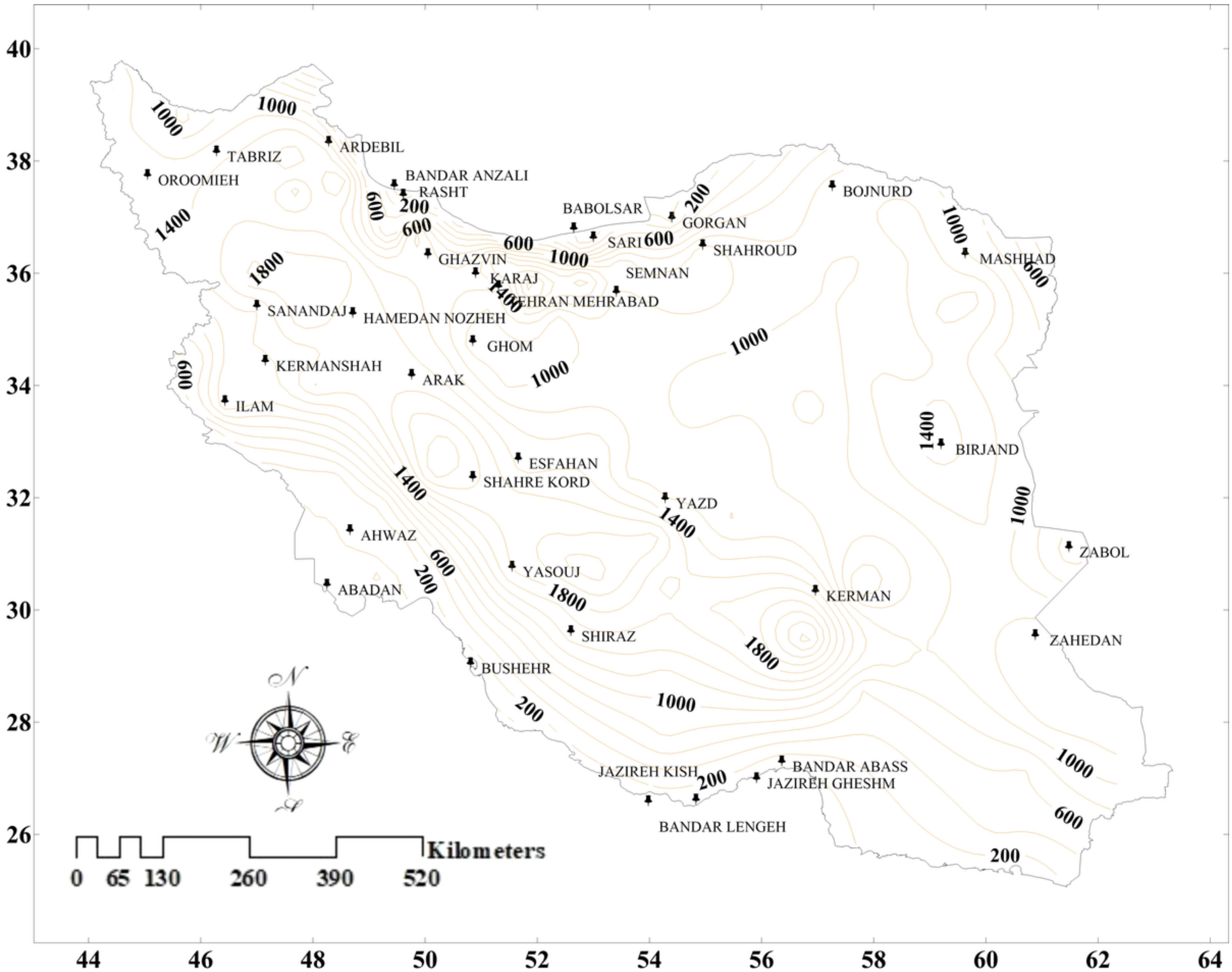

Figure 3

Elevation map in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

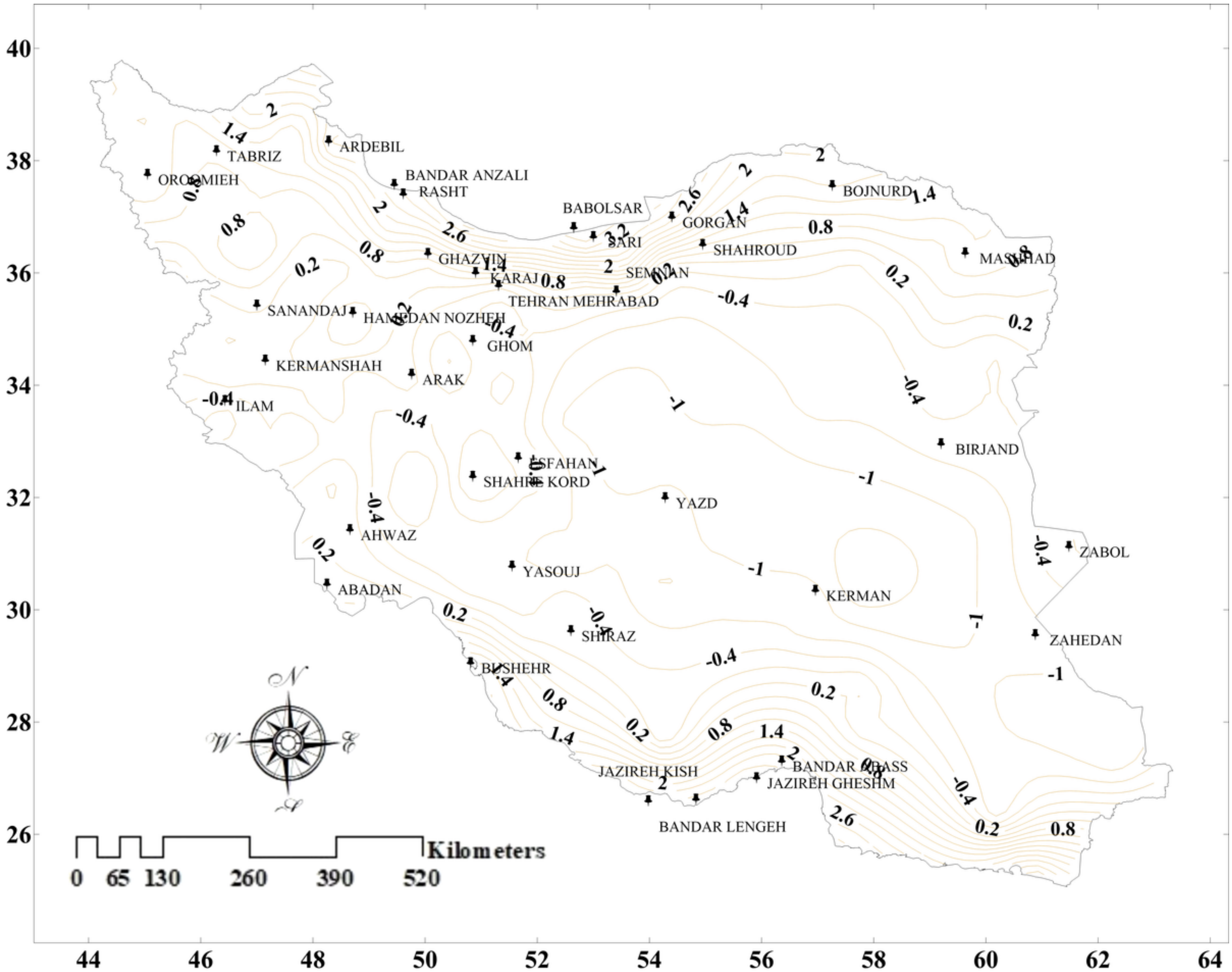

Figure 4

Distribution map of summer-spring precipitation factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

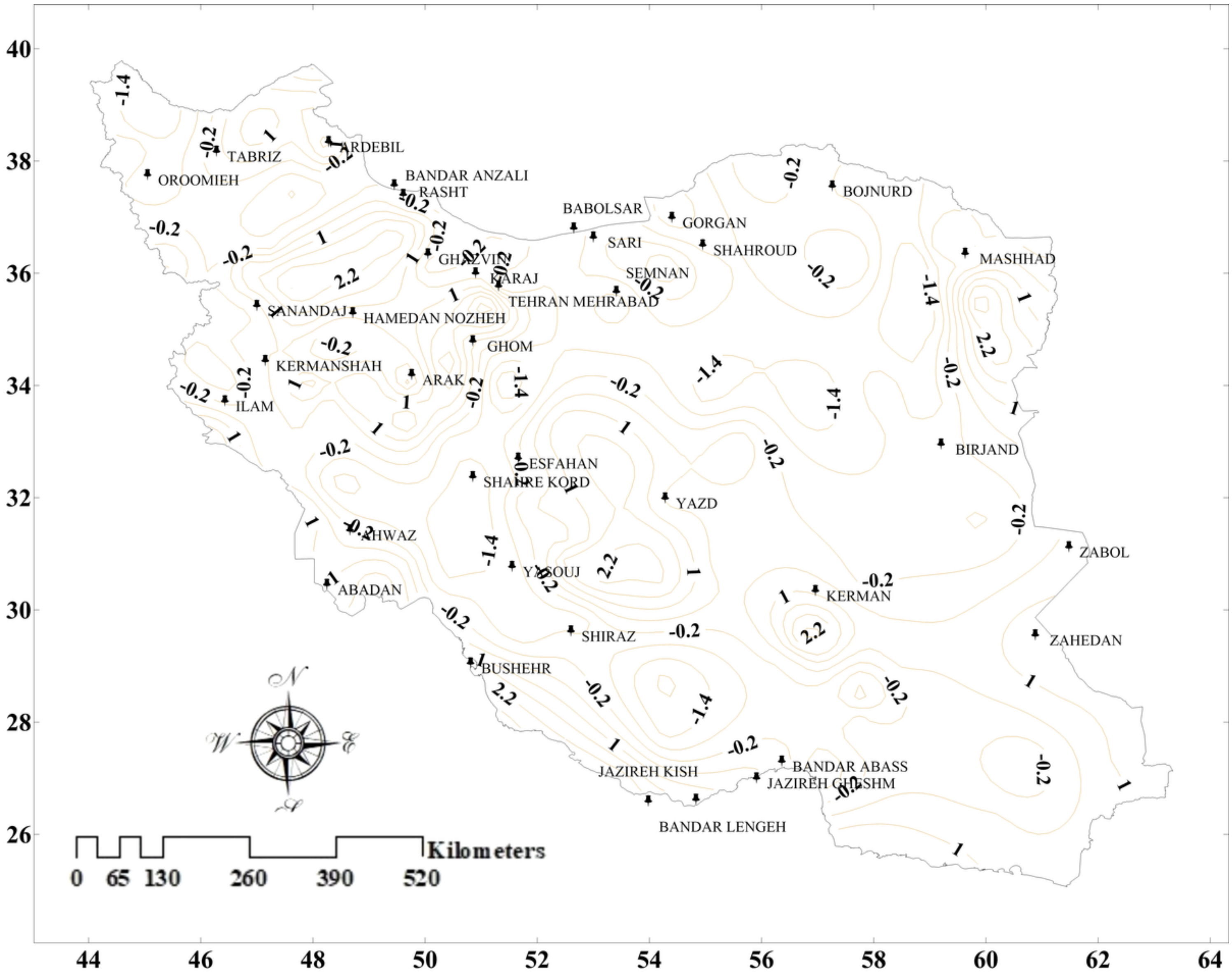

Figure 5

Distribution map of wind precipitation factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

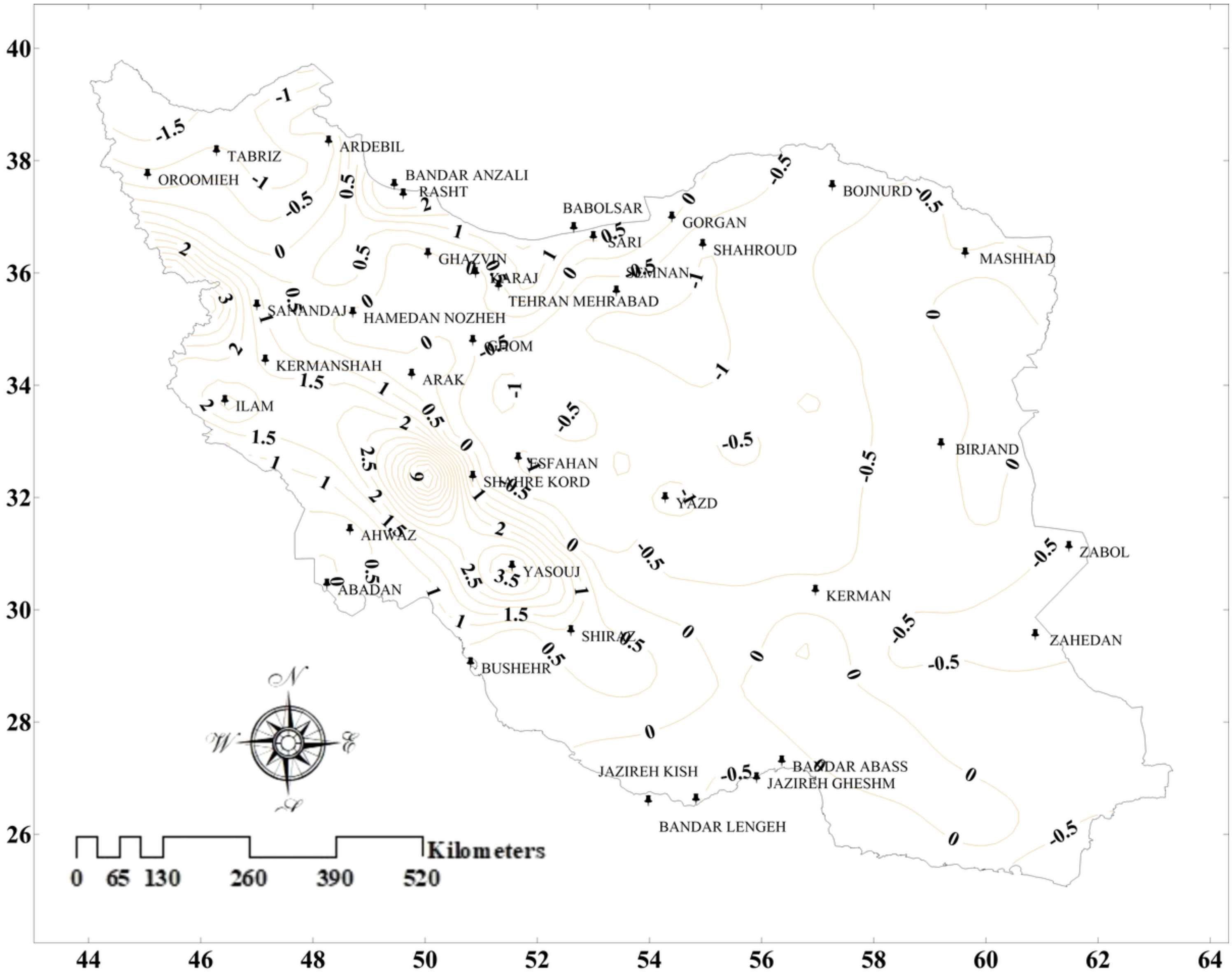

Figure 6

Distribution map winter-autumn precipitation factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

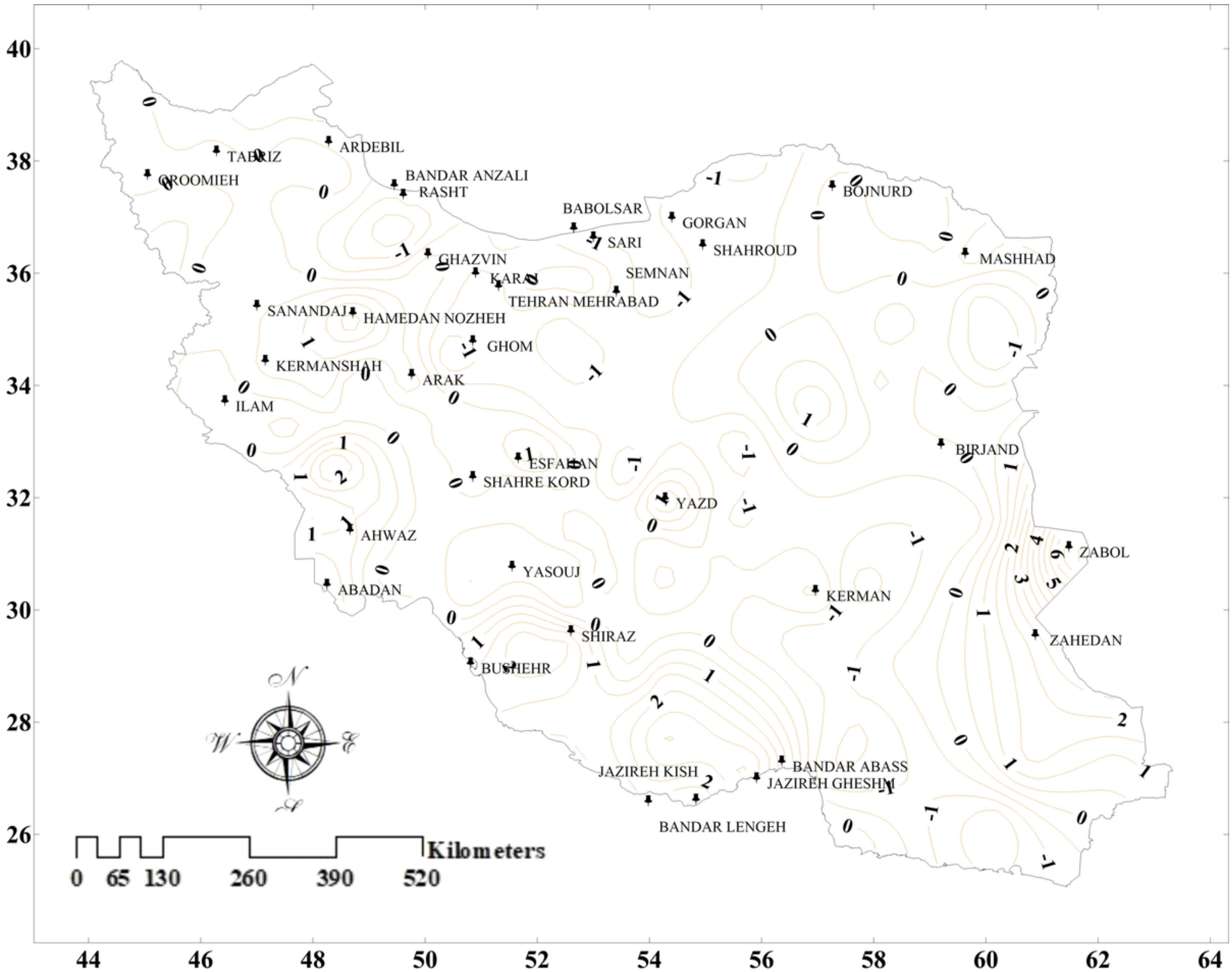

Figure 7

Distribution map of dusty days factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

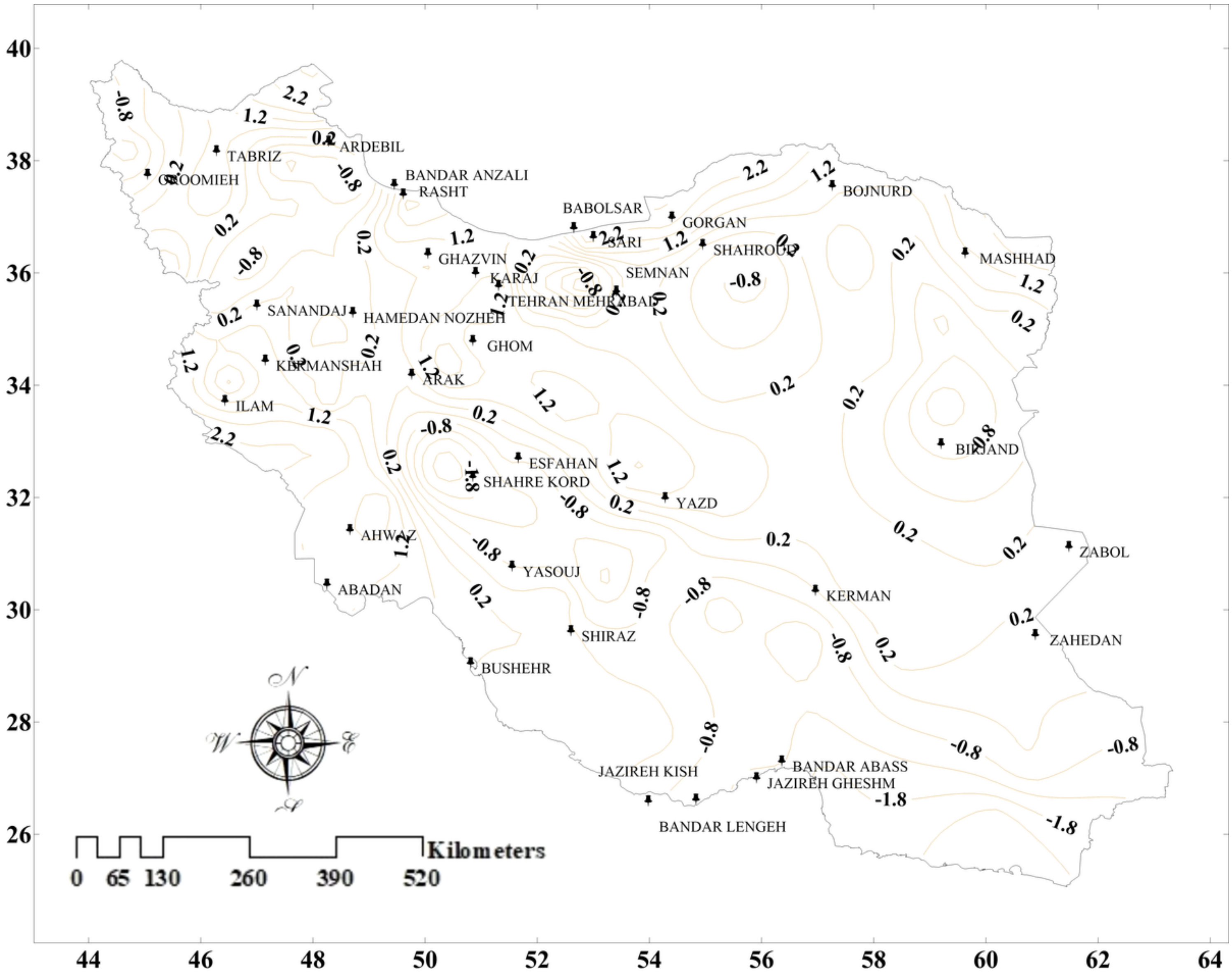

Figure 8

Distribution map of cloudiness factor scores in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

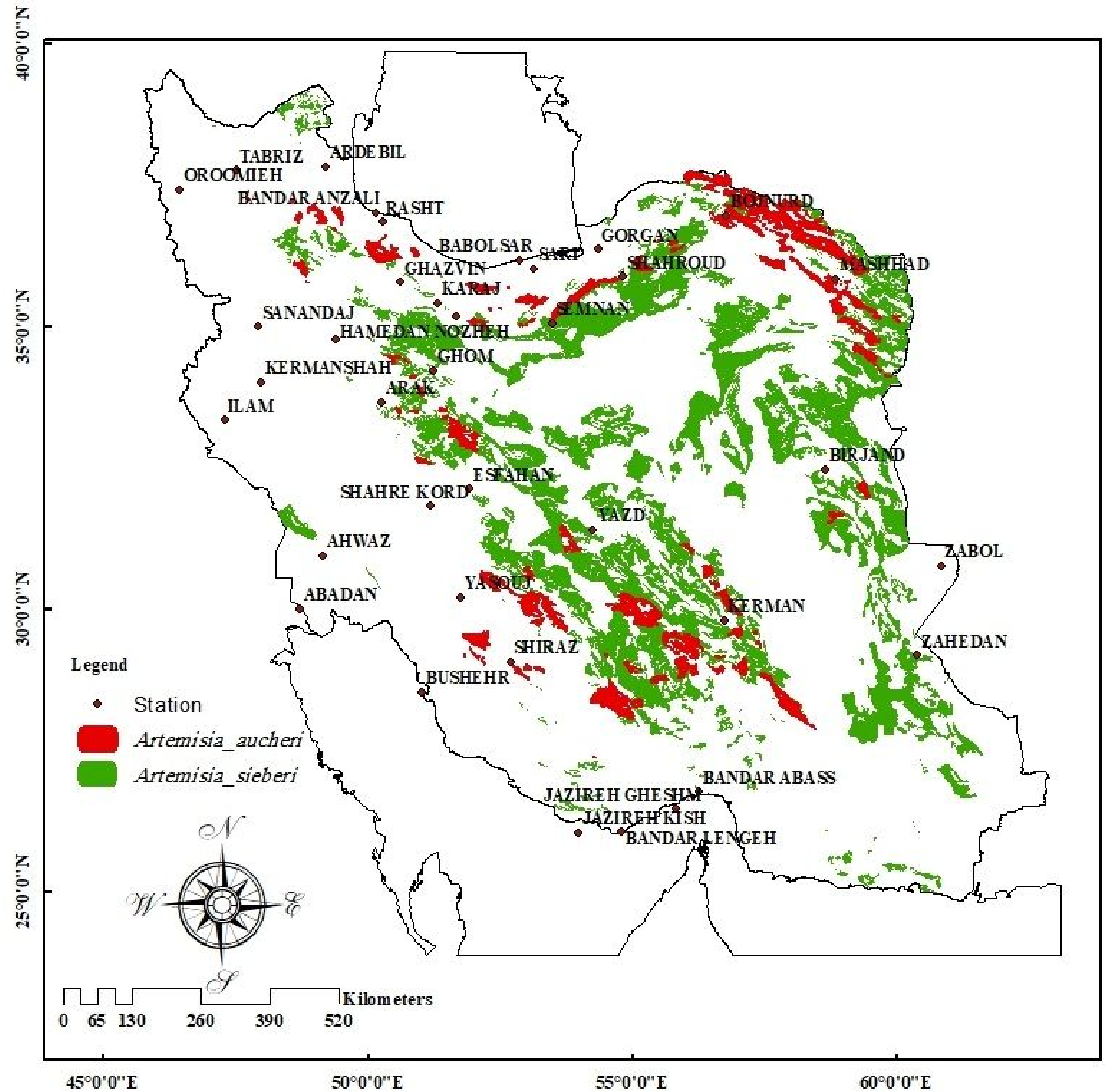

Figure 9

Distribution map of Artemisia sieberi and Aetemisia aucheri in Iran Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.