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Research Article

A Survey of the Monthly Trend of Relative Humidity in the Northwest of Iran in the Past Years

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Abstract

The climate of the planet has been changing ever since. One of the factors that affect the climate of the planet is water vapor. In this study, the data of 27 synoptic stations of northwest Iran were used to estimate the relative humidity trend in the northwest of Iran during the statistical period of 25 years. MATLAB and software with dimensions of 27×300 were obtained from the data representing time (moon) and columns representing the location. Using the Kriging interpolation method in the geographical information system, the trend maps and the monthly trend slope for January 1989 to December 2013 were developped. In this study, a regression model was used to calculate the time series process using least squares method, and the non-parametric Mann-Kendall test was used to identify the process. The results showed that the highest range of negative trend areas was observed in March with 81.5% of the area in the region, from -0.3 to -7.7% in decades, the highest in Bijar and its minimum in Zarinehabatu. Also, the lowest range of negative trend areas in October is seen with 3.7% of the area in Takab, a decrease of -4.0% in decades. The largest number of regions with a positive trend in September and November with 14.8% of the area in Mianeh, Zanjan, Khoramdarah, Hamedan Nogheh, Hamedan, Kangavar increased 0.3-0.5% in September and 2 in decades. 0 to 0.4 percent increase over the decade in November, and the lowest range of positive trends in the months of August and February with 3.7 percent of the area in Parsabad and Kangavar was 0.3 and 0.2 percent respectively, in the decade is visible.

Keywords: Relative Humidity, Regression, Northwest Iran, I – Kendall.

1. Introduction

In recent decades, climate change has been a major controversy among scholars as a result of global warming. The climate of the planet has been changing ever since. Signs of these changes come from ice cores, geological records, and more recently from tree rings and coral growth and historical documentary records. One of the factors influencing the climate of the planet is water vapor (Boroujerdi et al., 2011). Studies in the field of climate change in the world mainly indicate that in many parts of the Northern

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Hemisphere, climate change has been accompanied by an increase in atmospheric humidity. Increasing greenhouse gases in the atmosphere not only causes global warming but also changes the behavior of meteorological parameters, including humidity in the air. The increase in humidity in the air due to the increase in temperature that has occurred in many parts of the world is the result of the warming of the air. Much moisture in the atmosphere produces excess water for outdoor systems. At present, many extreme events such as lightning storms and excessive rainstorms or snowstorms are excessive due to available moisture (Rahimzadeh and Khoshkam, 2003). Relative humidity is one of the important variables in the atmosphere that is used in agricultural studies, sedimentation, hydrology, urbanization and the determination of evaporation from the free surface of water and evapotranspiration, etc. Considering these issues and considering that our country is located in the dry and semi-arid region of the world, studying the trend of relative humidity and understanding how it changes over time to use in future planning in areas such as agriculture and water management is important.

Humidity on the tropical seas, in the best case, occupies about 4% of the atmosphere. Moisture has three modes of steam, liquid and solid. The dominant mode of humidity in the atmosphere is water vapor. Total atmospheric humidity controls cloudiness, rainfall, viewing distance and temperature dispersion (Kaviani and Alijani, 2011). Usually, when it is referred to as moisture, the main reason is relative humidity (RH). Relative humidity is the ratio of the amount of water vapor in the air to the amount of water vapor that was saturated if the air was in the same degree. This ratio is expressed as a percentage. Whenever the amount of water vapor in the air becomes low or high or the water intake capacity changes in the atmosphere, relative humidity will also change. Relative humidity decreases inversely with a change in temperature. Reducing the degree of heat leads to a decrease in capacity, and if the water intake capacity decreases, the relative humidity of the air will be increased, as the air will be close to its saturation level (Alizadeh et al., 2012). Based on the climatic Atlas of the period from 1961 to 1990, a large part of the internal regions of the country had a relative humidity below 50%. Only on the shores of the Caspian Sea and limited sections From the Gulf coast and the Oman Sea, this average is above 70%. In the Lut Desert and Desert Desert, which covers a large part of the east and south-east of the country, this average is less than 30 percent (Rahimzadeh and Khoshkam, 2003).

Many studies have been carried out to study the process of various climate parameters in the world and in Iran, and some of them are mentioned. Gafen and Clay (1999) studied the climatic and humidity trends and surface temperatures in the United States using cluster data of 188 weather stations during the 1961-1990 periods. Lin et al. (2007) in a research using relative humidity values of 191 meteorological stations for 50 years during the statistical period of 1951-2000 by using the FA and DFA oscillation analysis method to investigate the spatial dynamics of longitudinal relativistic correlation of China, concluded that the ability to change the relative humidity fluctuations is greater than the change in temperature fluctuations, which varies from station to station, and shows both the spatial diversity and the time it can be explained by a proposed mechanism. Diaz et al. (2011) investigated variations in the mean vertical and moisture profiles in the Hawaiian Islands. The results indicate that a significant heat trend has been observed especially at high altitudes. In a study using NCEP data for four districts in Iraq as different weather regions, Alobaid (2015) studied relative humidity in Iraq during the statistical period of 1951-1951. He used the Kendall test to determine the relative humidity trend. The results showed that the relative humidity in the four cities has a decreasing trend. Zelenakovaet al., (2016) in a research to determine the precipitation trend using the Mann-Kendall statistical test in 487 measuring stations in Slovakia during the statistical period of 1981-2013, and concluded that the rainfall trend has a high degree of variation.

The rainfall season in Slovakia in the metering stations, especially in July, has an increasing trend. Khordadi et al. (2007) in a study using parameters of temperature, relative humidity, wind speed and rainfall during the statistical period of 1951-2005 in three regions of Iran including Tabriz, Mashhad, Shiraz using three Man-Kendall tests, cumulative deviation and Regression analysis evaluates the process of meteorological parameters in several regions of Iran. The results of the study showed that the relative humidity parameter in each of the three regions showed a sustained decrease trend. Jahanbakhsh et al. (2010) investigated the long-term annual relative humidity variations at Zahedan station using the medium and maximum series and the minimum seasonal humidity, and concluded that the average, minimum and maximum relative humidity at the Zahedan station has a trend Reduced. Maleki and Asakereh (2011) studied the effect of relative temperature and relative humidity on rainfall during recent decades in Zanjan during the statistical period of 1956-2005. They determined the correlation between temperature and precipitation by Pearson correlation coefficient and also calculated the simultaneous effect of temperature and relative humidity on precipitation. The results showed that there is no linear relationship between temperature and precipitation. In second regression, the variable temperature did not have a significant effect on rainfall, but relative humidity was an effective variable in precipitation of this station.

Bassati et al. (2014) studied the variation of rainfall patterns and reveal the relative humidity and temperature on it for Kermanshah Station during the statistical period of 1981-2010. To calculate the relationship between the number of rainfall days and temperature and relative humidity of Pearson correlation, I used Kendall test, Pearson correlation coefficient and regression analysis to investigate the change trend. The results show that the number of days of types of precipitation has been decreasing trend. There is also a relatively strong and severe correlation between the types of precipitation with relative humidity and temperature. Jafarpour et al. (2015) studied the weather data of Ardabil station with a period of 39 years (1976-2014) and nonparametric Mann-Kendall tests and age estimator estimators at the Ardabil synoptic station. The results showed that the time variations of temperature and precipitation were incremental and decreasing respectively and the effect of human effects on the time series and its natural process has been effective. Maleki and Asakereh (2011) concluded that using the RegCM4 model, it was concluded that in the coming decades, the highest degree of heating demand for January-February in the mountainous regions of the Northwest and Central Zagros is between 6,000 and 5000 degrees. Trend analysis is one of the most important statistical methods widely used by researchers to assess the potential impacts of climate change on hydrological time series such as temperature, precipitation, relative humidity and other elements in different parts of the world. Station is (point).

In this research, we try to complete the monthly changes in relative humidity of northwest of Iran using the data of 25 years (1989-2013) using the nonparametric Mann-Kendall test and the least-squares detection and research method.

1.1. The study area

The northwest of Iran, with an area of over 192.81 km², adjacent to the countries of Iraq, Turkey, Azerbaijan and Armenia, is one of the most important hubs of Iranian population and agriculture. In terms of overall climatic divisions, the climatic characteristics of the region are part of the semi-arid climate, which is almost dry in the summer and the rest of the seasons are wet. Figure 1 shows the geographical location of the stations studied and Table 1 shows the geographic coordinates of the stations studied and the statistical period of each station.

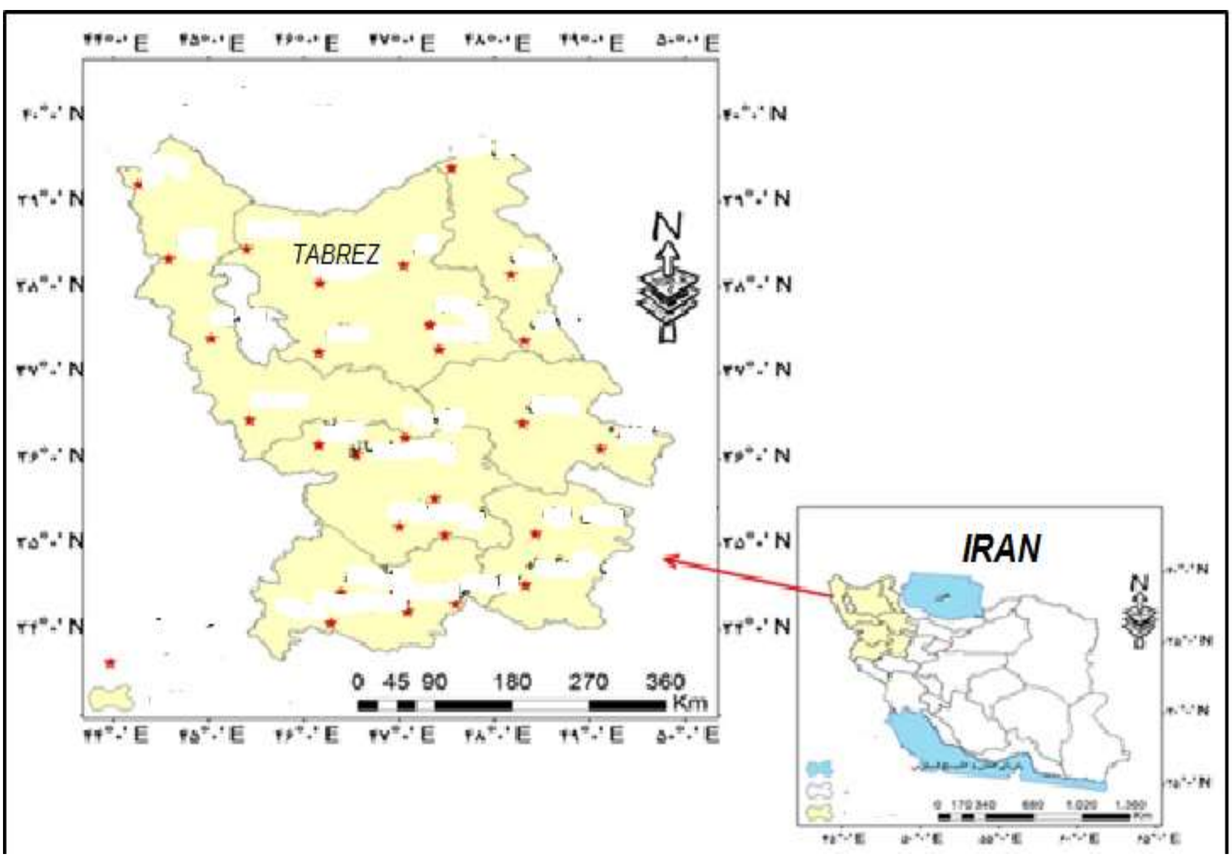

Figure1: Geographic location map of the studied stations.

Table 1: Geographical coordinates of the stations studied and statistical period of each station

Sr. No.	Name of Station	Stage length (years)	Longitude (E)	Latitude (N)	Elevation (m)
1	Ardebil	25	48° 17’	38° 15’	1332
2	Khalkhal	25	48° 31’	37° 38’	1796
3	Pars abad	25	47° 55’	39° 39’	31/9
4	Tabriz	25	46° 17’	38° 5’	1361
5	Ahar	25	47° 4’	38° 26’	1390/5
6	Jaffa	25	45° 40’	38° 45’	736/2
7	sarab	25	47° 32’	37° 56’	1682
8	Maragheh	25	46° 16’	37° 24’	1477/7
9	Mianeh	25	47° 42’	37° 27’	1110
10	Urumia	25	45° 3’	37° 40’	1328
11	Takab	25	47° 6’	36° 24’	1817/7
12	khooy	25	44° 58’	38° 33’	1103
13	makoo	25	44° 26’	39° 20’	1411/3
14	Mohabad	25	45° 43’	36° 45’	1351/8
15	Zanjan	25	48° 29’	36° 41’	1663
16	Khoramdare	25	49° 11’	36° 11’	1575
17	Bijar	25	47° 37’	35° 53’	1883/4
18	Zarine Abato	25	46° 55’	36° 4’	2142/6
19	Saghes	25	46° 16’	36° 15’	1522/8
20	Sanandaj	25	47° 0’	35° 20’	1373/4
21	Ghorveh	25	47° 48’	35° 10’	1906
22	Islamabad West	25	46° 28’	34° 7’	1348/8
23	Ravensar	25	46° 39’	34° 43’	1379/7
24	Kermanshah	25	47° 9’	34° 21’	1318/6
25	Kangavar	25	47° 59’	34° 30’	1468
26	Hamedan airport	25	48° 32’	34° 52’	1741/5
27	Hamedan Nahavi	25	48° 43’	35° 12’	1679/7

2. Data and Methodology

The relative humidity data of 27 synoptic stations in the northwest of Iran during the statistical period of 25 years have been used to evaluate the relative humidity in the northwest of Iran. Matlab and Excel (MATLAB) software received a matrix of 27 × 300 dimensions from the data that represent the time (moon) and the columns representing the location, and using the ArcGIS interpolation method (Arc Gis). The trend maps and slope of the monthly relative humidity process were plotted for January 1989 to December 2013. In this research, a regression model was used to calculate the trend of time series using least squares method (the second lowest power), and the non-parametric Mann-Kendall test was used to identify the trend. Both steps are coded in MATLAB software.

2.1 The least power of the second

In the method of the least power of the second, the data are fitted to a linear trend and the regression coefficient is calculated by the following relationships Maleki and Asakereh (2011):

Relationship (1): $y=a+\beta x$

Dependent variable, controlled variable, width from origin, line gradient

Relation (2): $\beta=\frac{N\sum ny-\sum x\sum y}{N\sum x2-(\sum x)2}$

Number of data: a=y-βx N: Relation (3)

x : Mean , y mean , y

It is clear that a positive amount for β an indicator of relative humidity increase with time is a negative value for β a relative humidity reduction indicator with time. To β=0 confirm the existence of the process is not verified. But since β the value is unknown, an β estimate of 95% is obtained from the following relationship:

Relation (4) :β=t 0/02= $\frac{s}{sx}$

β Estimated errors:= $\frac{s}{sx}$

Deviation from the mean, non-standard estimator of the standard deviation

Relation (5): s=$\sum_{i=1(yi-a\beta xi)/(n-2)}^{n}$.

Degrees of freedom: n-2

Relation (6): sx=$\sum(xi-x)=\sum xi-nx$

If the upper and lower β limits are both positive, we do not reject the assumption of an increasing trend in relative humidity. If the upper and lower β limits are both negative, we do not rule out the assumption of a decreasing trend in relative humidity, and if the upper and lower β limits are marked differently, we do not approve the assumption of the trend.

2.2 Mann-Kendall non-parametric test

My non-parametric test, Kendall, was originally developed by Mann in 1945 and then developed by Kendall in 1975. The zero assumption of this test implies randomness and lack of trend in the data series, and acceptance of the hypothesis (zero assumption) implies the existence of trend in the data series. Considering that for the first time, the slope of the trend and the zoning of the trend in the form of coding and mapping of the map in Iran was carried out by Masoudian et al. (2012). To evaluate the degree of day, which, given the precision of doing this by coding in MATLAB software, after learning this software steps The following is used to identify the process using the non-parametric Mann-Kendall test as coding (Masoudian et al., 2012):

2.2.1 Calculate the difference between each single sentence of the series with each other and apply the sgn function and extract the parameter s

Relation (7):s=$\sum_{k=1}^{n-i}\sum_{j=k+1}^{n} sgn(xj-xk)$

Where n is the number of series observations x_j and x_k, respectively, the j and k data series. The output of the above function makes the mark of each series as follows:

Relationship (8): sgn(x) = $\begin{bmatrix} +1 & if(xj-xk)> & 0 \\ 0 & if(xj-xk)= & 0 \\ -1 & if(xj-xk)< & 0 \end{bmatrix}$

2.2.2 Calculate the variance using the following equation:

Relation (9) if: n> 10 var (s) = (n (n-1) (2n + 5)) / 18 relation (10) if: n <10 n≤10

where n is the number of observable data, m denotes the number of series in which at least one duplicate data exists and t represents the abundance of the same value data.

2.2.3 Extracting the z test statistic using one of the following relationships**:**

Relationship (11): z=$\begin{bmatrix} \frac{s-1}{\sqrt{\text{var(s)}}} & if & s>0 \\ 0 & if & s=0 \\ \frac{s+1}{\sqrt{\text{var(s)}}} & if & s<0 \end{bmatrix}$

2.2.4 Assumption test

The zero assumption implies that there is no trend and that it is random. In other words, z is not statistically significant. The opposite assumption or assumption is a sign of the existence of the process, which means that z is statistically significant. In the mentioned relationship, a significant level is considered for the test, which is performed for 95% significant levels. This statistic is considered equal to 95% confidence level. If z is smaller than zero, we will confirm the negative trend of relative humidity and, if z is greater than zero, we will not reject the relative humidity.

3. Results

3.1 Locational and temporal analysis of monthly average relative humidity:

Figures 2 and 3 show the trend of average relative humidity in the first and second half of the year, such as given in Table 2 and Figure 4, respectively. The percentage of areas with positive, negative and no trend is the average relative humidity in the study area. The monthly relative humidity trend in the northwest of Iran over a period of 25 years was calculated at a significant level of 5%. According to Figures 2 and 3 in January, the size of areas without trend (81.5%) is higher than those with negative trend (18.5%).

In February, except for Parsabad station in the north, with relative humidity (3.7%) and Khalkhal, Saqez and Hamedan stations with negative trend of relative humidity (11.1%), the rest of the regions are not trendy. In March, except in the Parsabad, Jolfa, Khoy, Middle and Takab stations with no trend (18.5%), in other regions there was a negative trend of relative humidity. The April months lack specific trends in relative humidity. In June, except for a very small extent in the south of the region (7.4%), the relative humidity trend, which includes Hamedan airport and Kermanshah stations, is much more pronounced without relative humidity (92.6%). In July, the negative trend of relative humidity was observed in three stations of Mahabad, Kermanshah and Hamedan (11.1%) and in stations Zanjan and Kangavar (7.4%) were positive.

In August, except Kangavar station (3.7%), with positive trend and Ardebil, Hamedan and Kermanshah stations (11.1%) with negative trend, in other regions there are conditions without relative humidity. In September, 14.8% of the area of the region, including the central stations, Zanjan, Khoramdar and Kangavar, has a positive trend and the rest (85.2%) are without trend. In October, except for 3.7% of the area with a negative trend that includes the Takab station, there is no particular trend in the remaining regions (96.3%). In November, 14.8% of the area of the region located in the southeast of the study area (Khoramdareh, Hamedan Nogheh, Hamedan and Kangavar stations) has a positive trend of relative humidity and the rest of the area has no particular trend in relative humidity. In December, at Ahar and Khalkhal stations (with 7.4% of the area), we see a negative trend of relative humidity and relative humidity in the rest of the regions is not a particular trend.

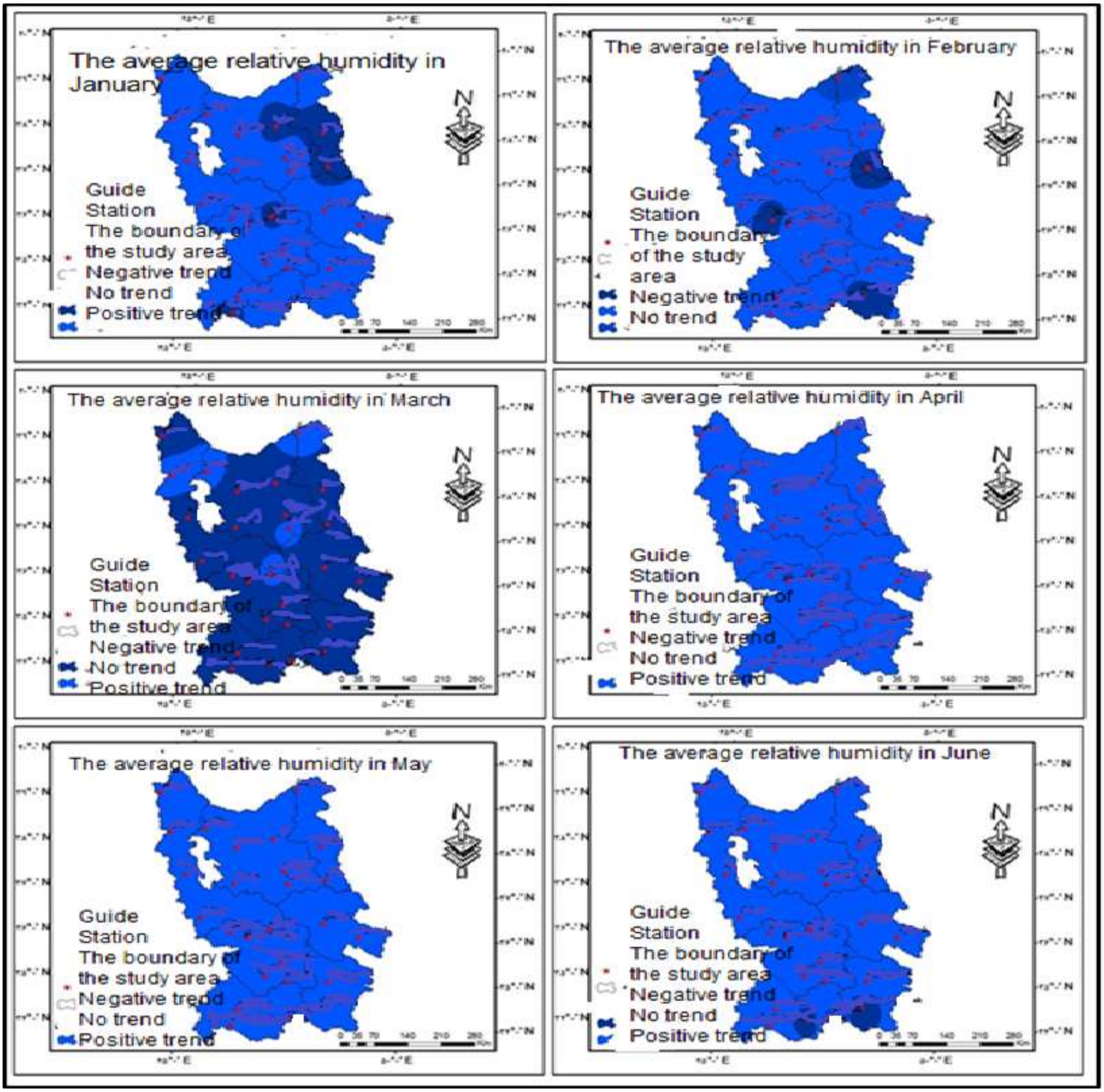

Figure 2: Average relative humidity trend of the first half of the year (Cont.)

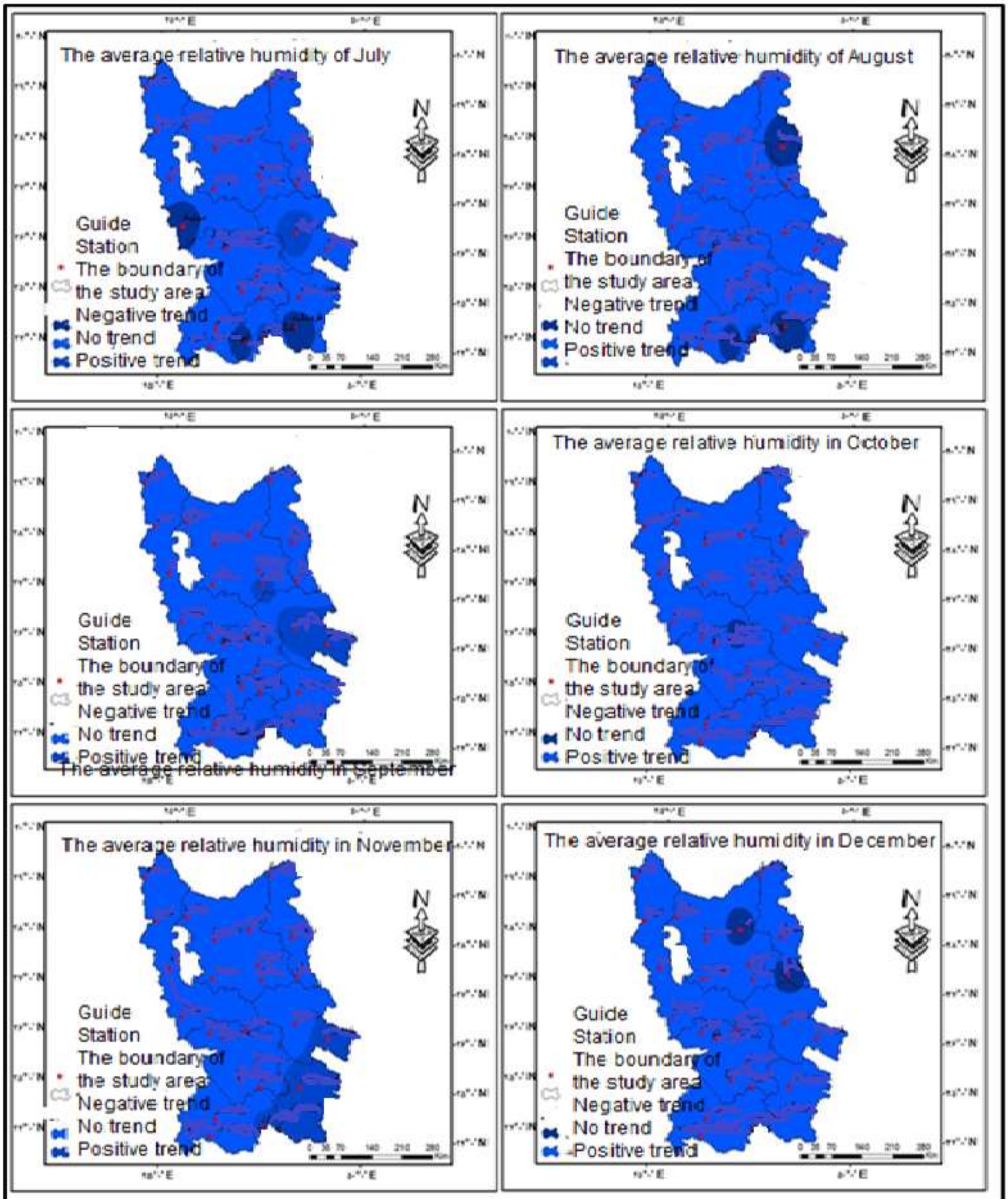

Figure 2: (cont.)

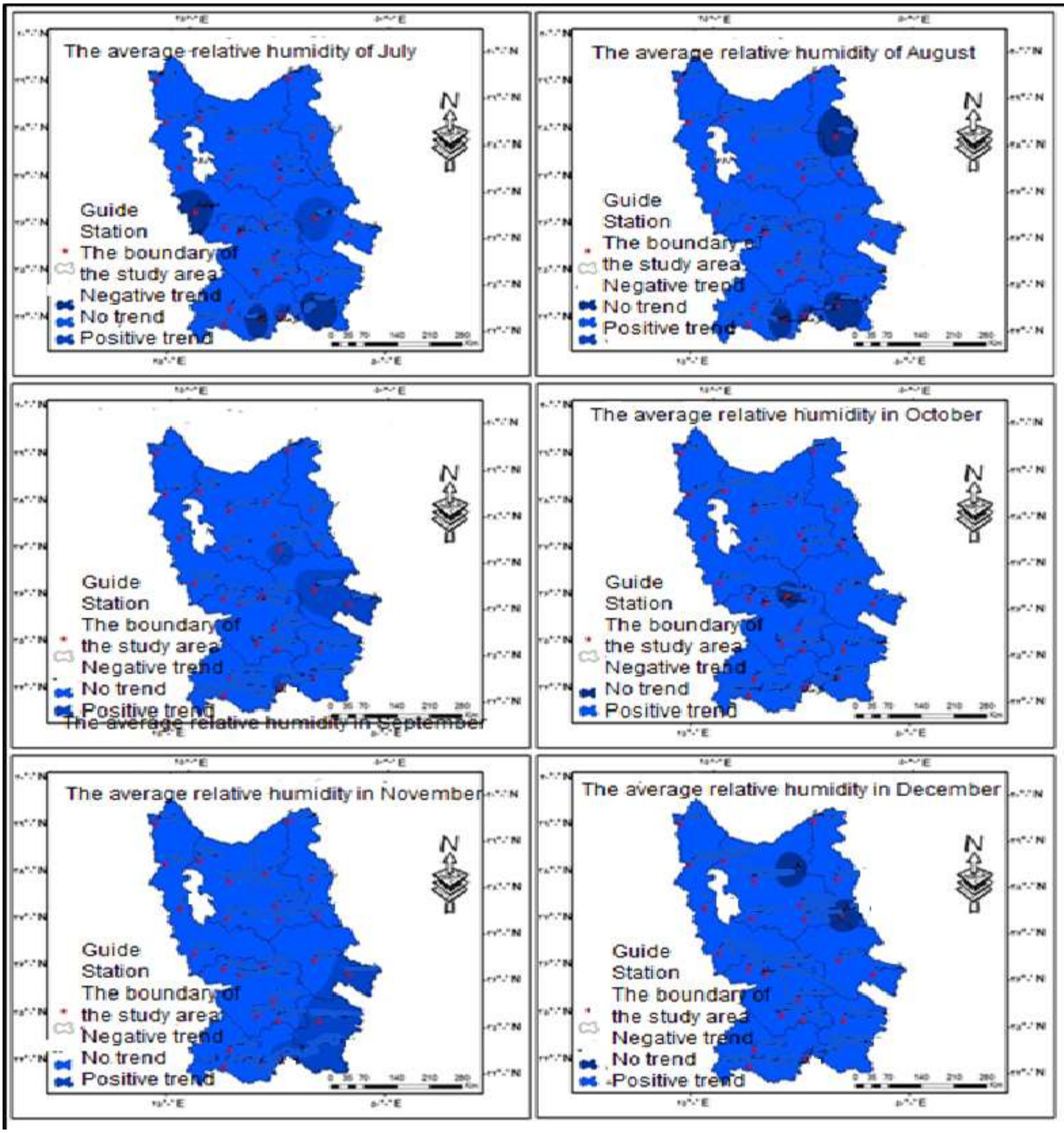

Figure 3: Average relative humidity trend of the second half of the year.

Table 2: The percentage of areas with positive, negative and no trends in relative humidity in the study area.

Month	Negative	No Trends	Trend Positive
January	18/5	81/5	0
February	11/1	85/1	3/7
March	81/5	18/5	0
April	0	100	0
May	100	100	0
June	7/4	92/6	0
July	11/1	81/5	7/4
Aug	11/1	85/2	3/7
September	0	85/2	14/8
October	3/7	96/3	0
November	0	85/2	14/8
December	7/4	92/6	0

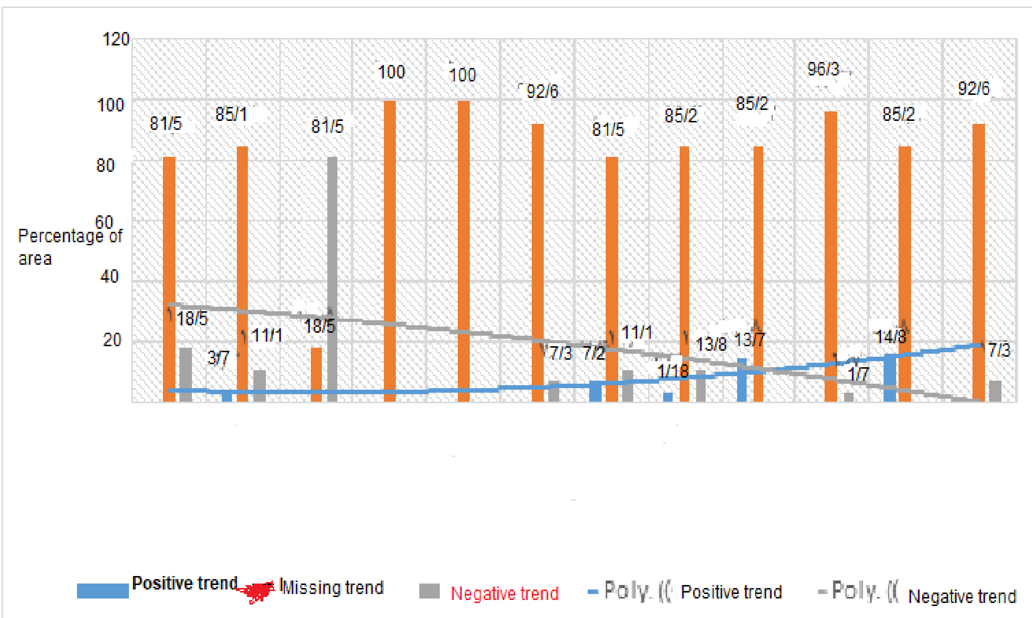

Figure 4: The percentage of areas with positive, negative and no trends in relative humidity in the study area (2017)

3.2 Location and temporal gradient Monthly average relative humidity

In the study area (northwest Iran), in areas with negative trend of relative humidity, we observe the slope of the decrease in relative humidity and in regions with positive relative humidity trends, we see a slope of the relative increase in relative humidity. Figures 5 and 6 show the slope of the average relative humidity in the first and second half of the year in percentage terms in decades.

According to Figures 5 and 6 in January, the slope of the relative humidity trend in the northeast, center, and end of the southwest of the study area was (-0.5) -0.3 (-0.0) percent decline in the decade. Meaning that during this month, the average relative humidity decreases from -0.3 to -0.5 per decade), with a maximum of -0.5 percent in the Ahar station during the decade and a minimum of -0.3 percent in decades In Takab. In general, 18.5% of the area has a slope slope. In February, the slope of the relative increase in average relative humidity was only 0.2% in Parsabad Station in the decade and at Khalkhal, Saqez, Hamedan stations that cover 11.1% of the area, the slope of the relative humidity decreases to (-0.4%) (-0.2%) in the decade, its maximum at the airport in Hamedan at -0.4% in the decade and the minimum at -0.2% in the decade in Saqez. In March, the greatest extent of slope was the decreasing trend of relative humidity (81.5% of area) in the range of -0.3 to -7.7 per decade, the maximum of which was Bijar (-0.7%), and the minimum was related To Zarineboat, the relative humidity was reduced by -0.3 percent every decade.

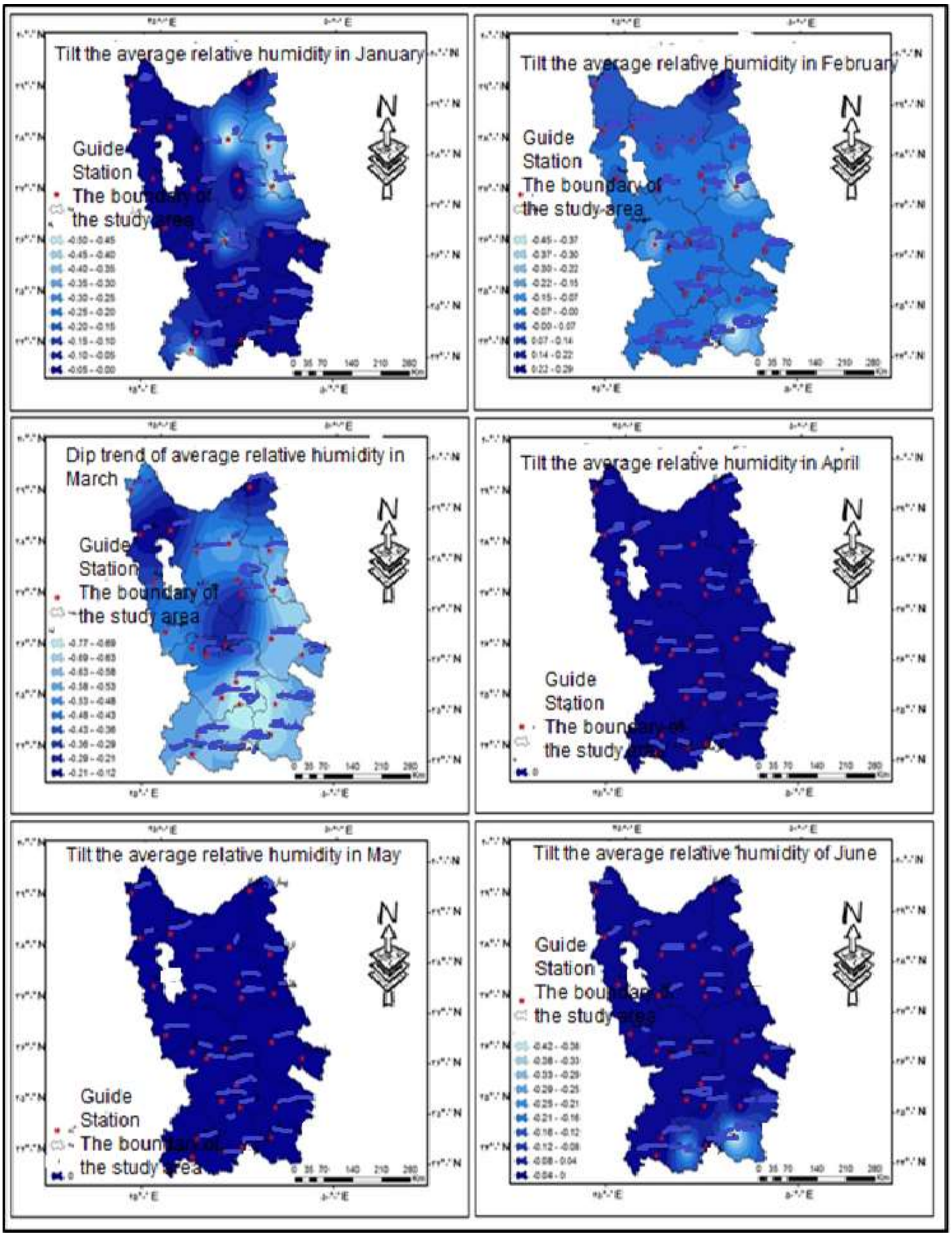

Figure 5: Slope of the average relative humidity of the first half of the year.

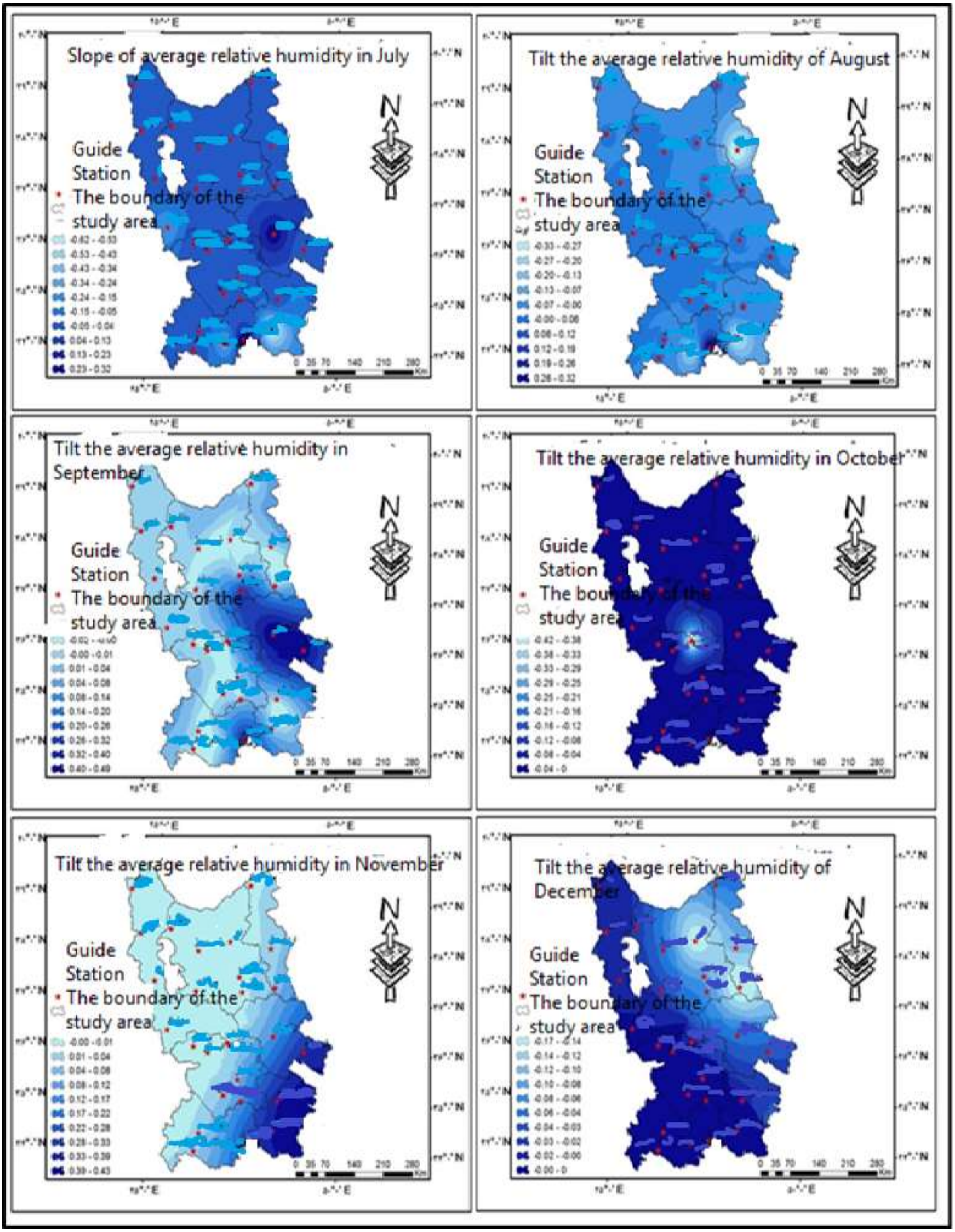

Figure 6: Slope of the average relative humidity of the second half of the year.

April and May are trendless and trendless. In June, only 7.4% of the area of the slope area has a decreasing trend, the maximum at the Hamadan airport (-0.4% decrease in decades) and its minimum at Kermanshah Station (-0.3% decrease over the decade). In July, Zanjan and Kangavar stations tended to show an average relative humidity rate of 0.3% in decades. The stations in Mahabad, Kermanshah and Hamedan at the slopes have reduced relative humidity by -0.6 (-0.2) 0-) percent in the decade. In August, the slope of the incremental trend was observed only at the Kangavar station at 0.3% in decades, and the slope of the relative humidity decline was (-0.3) - (-0.2) per decade, the highest in Ardebil (-0.3 percent in decades). In September, 14.8% of the area of the slope area has an increasing percentage of relative humidity ranging from 0.3 to 0.5% in decades, with a maximum of 0.5% in the decade and a minimum in the middle range 0.3 percent in decades. In October, the slope of the decrease in the average relative humidity was only more significant at the Takab station by -0.4 percent in the decade. In November, 14.8% of the area of the region in the southeast region shows a steady increase in relative humidity of 0.2-0.4 percent in decades. In December, Khalkhal and Ahar stations declined the relative humidity by -11.5% (-14.1%) in the decade.

4. Conclusion

In recent decades, climate change has been a major controversy among scholars as a result of global warming. The climate of the planet has been changing ever since. Studies in the field of climate change in the world mainly indicate that in many parts of the Northern Hemisphere, climate change has been accompanied by an increase in atmospheric humidity. In this research, trend and slope of the average relative humidity in the northwest of Iran were investigated monthly and the results showed that the maximum range of negative trend areas in March with 81.5% of the area of the area was -0.3-0.7 Decreasing percentages in decades at Ardebil, Khalkhal, Ahar, Tabriz, Sarab, Maragheh, Maku, Urmia, Mahabad, Saqez, Zanjan, Khoramdareh, Zarinehabato, Bijar, Ghorveh, Sanandaj, Hamedan Nogheh, Hamedan, Kangavar, Kermanshah, Islamabad and Ravansar, whose maximum is in Bijar and its minimum in Zarinabato. Also, the lowest range of negative trend areas in October is seen with -7.4 percent in the decade with 3.7 percent of the area in the center of the region (Takab).

The largest range of regions with a positive trend in the months of September and November with 14.8% of the area in the eastern region (Middle, Zanjan, Khoramdarah, Hamedan Nogheh, Hamedan, Kangavar) increased by 0.3-0.5% in the decade In September, the 0.2% increase was observed in the November decade, and the smallest positive trend in August and February with 7.3% of the area in the north east and south of the region (Parsabad and Kangavar) was respectively An increase of 0.3 and 0.2 percent is seen in decades. Except for March, with 18.5% of the area without a trend in the north and center of the region (Parsabad, Jolfa, Khoy, Takab, Middle), in the remaining months the trend is higher than trend conditions and the months of April are lacking any particular trend. In general, the average relative humidity trend over a 12-month period can be deduced that the highest range of negative trends was observed in March (81.5%) and the lowest range of negative trend areas in October (3.7% of actual area In the center of the region). In the positive trend of September and November, with an average of 14.8% of the area in the east of the study area, the highest range was observed in the months of the year and months of August and February (3.7% of the area in the north-east And south of the region) have the smallest range. Except for March, with 18.5% of the area without trend, for the rest of the months, conditions without the average relative humidity trend are more sovereign.

The months of February, July, August include the positive and negative average relative humidity trends, and the months of January, March, June, October, and December include the negative average relative humidity trend and the September-November months, including the positive trend of relative humidity. The April months lack specific trends in relative humidity. A significant decrease in relative humidity in March was due to a further decrease in temperature in the areas mentioned earlier this month, indicating an inverse relationship between temperature and relative humidity.

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