INVESTIGATION HAZARD EFFECT OF MONTHLY FERRRIN TEMPERATURE ON AGRICULTURAL PRODUCTS IN NORTH BAR OF IRAN

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ABSTRACT

The objective of this study to investigating and predicting the hazardous effects of monthly Ferrin temperature on horticultural and agricultural products at the North bar of Iran. For this purpose, the first stage data were obtained for the whole station temperature over a period of 30 years. Then, using Anfis adaptive neural network model, the data were analyzed for prediction and prediction for the next 6 years. Then, to measure the land suitability of Iran's northern strip for cultivating based on the predicted data, two models of Vikor and Topsis were used. Both the Topsis and Vikor multivariate decision making models combined the minimum temperature of the stations well, but did not reflect well at the maximum temperature in the worst-priority stations. According to the findings of the study, with respect to the friction frain modeling, the maximum temperature showed the lowest defect compared to the minimum temperature. In Golestan province, the maximum temperature peaks and at least both are in weak increment, but in Gilan province, the maximum temperature peaks and at least both the maximum and maximum temperatures are higher. Mazandaran province showed maximum temperature and minimum temperature in both incremental and minimum temperature conditions.

Keywords: land , predict , horticulture , Gilan , Golestan , multivariate Mazandaran.

كشف عن تأثير درجات الحرارة الشهرية على الانتاج الزراعي في شمال ايران

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المستخلص

الهدف من هذه الدراسة هو التحقيق والتنبؤ بالآثار الخطرة لدرجة حرارة فيرين الشهرية على المنتجات البستانية والزراعية في البار الشمالي لإيران. لهذا الغرض، تم الحصول على بيانات المرحلة الأولى لدرجة حرارة المحطة بأكملها على مدى 30 سنة. باستخدام نموذج الشبكة العصبية التكيفية للأنفس، تم تحليل البيانات للتنبؤ خلال السنوات الست القادمة. بعد ذلك، تم قياس مدى ملاءمة الأراضي في القطاع الشمالي من إيران للزراعة استنادًا إلى البيانات المتوقعة، تم استخدام نموذجين لفيكور وتوبسي. وقد جمعت كل من نماذج صنع القرار المتعددين في توبسيس وفيكور الحد الأدنى من درجة حرارة المحطات بشكل جيد، لكنها لم تنعكس بشكل جيد عند درجة الحرارة القصوى في المحطات ذات الأولوية الأسوأ. وفقا لنتائج الدراسة ، فيما يتعلق بنمذجة منافسة الاحتكاك، أظهرت درجة الحرارة القصوى أقل تأثيرا بالمقارنة مع درجة الحرارة الدنيا. وفي مقاطعة كولستان، تكون القمم القصوى للحرارة وعلى الأقل كلاهما في حالة ضعيفة، ولكن في مقاطعة كيلان، تكون درجات الحرارة اعلى. أظهر إقليم مازندران أقصى درجات الحرارة ودرجة الحرارة الدنيا في كل من درجات الحرارة العالية والدنيا.

كلمات مفتاحية: الأرض، التنبؤ، البستنة، كيلان، كلستان، متعدد المتغيرات مازندران.

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INTRODUCTION

Climate change is one of the prominent challenges of the current century. Meanwhile, temperature changes as one of the most basic climatic elements of every area are of particular importance. Since temperature is one of the key elements of climate formation and considering studies conducted on the importance of temperature for horticultural and agricultural products and the experience on the study methodology, it can be stated that the parameter of temperature is important for cultivation of horticultural and agricultural products. Bozyurt *et al*. (2) investigated the relationship between northern fluctuations and minimum temperatures in Turkey and obtained results as index values of North Atlantic fluctuations, the minimum temperature in Turkey increased. The reason could be that the western winds have a lot of wet and hot air to the Mediterranean Basin and moderate the weather. Rao *et al*. (11) examined the increasing trend of minimum temperature and its impact on agricultural production in India during recent decades. Results showed the loss of caviar yield from 411 to 859 kg/ha at 1 °C, which indicates the increase in minimum temperature. This warming trend is likely to continue with significant criteria in the product yield and demands the development of appropriate adaptation strategies for production preservation. Singh et al. (13) examined the trend of the maximum and minimum temperature predicted in the Himalayan area. Results predicted that an increase in minimum temperature in Rampur will continue in the future, since the increasing trend will be obtained in both scenarios. The analysis of seasonal trend showed that there are many variables affecting the maximum and minimum temperature over this station for future periods. Dimri *et al*. (5) studied the future changes in minimum and maximum temperatures in the Himalayas. the overall trend of the daily temperature range (DTR) showed an increasing trend across the region, which had the highest value at RCP8.5. This higher increasing rate was higher for the maximum temperature than minimum temperature. The purpose of this study was to obtain the necessary data and the general and specialized use of minimum and maximum temperature data at the north bar of Iran (Golestan, Gilan and Mazandaran provinces) related to the planning, reviewing and predicting the hazardous effects of monthly Ferrin temperature on horticultural and agricultural products. For this purpose, the temperature data were analyzed and then the temperature for the next six years was predicted using ANFIS model and finally, Vikor and Topsis were used for prioritization of the lands in north bar of Iran.

MATERIALS AND METHODS

After collecting Ferrin temperatures, the necessary analyzes for error modeling and their prediction were done using the adaptive neuro-fuzzy inference system (Anfis). Finally, the two multivariate decision making models of Vikor and Topsis were used to prioritize lands for cultivating.

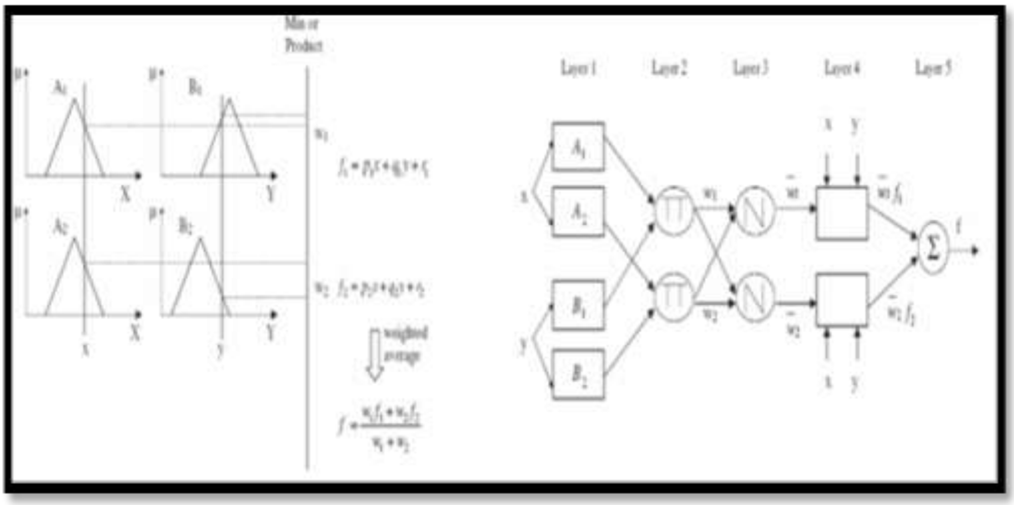
Methodology of drought prediction process with time series

At this stage, it is possible to model and predict dust in the study area using the ANFIS model. In this study, the dust phenomenon was studied in a series of time of 276 months (23 × 12=276) at two time scales of 6 and 12 months at each stations were considered. In a time series consisting of n samples, x1, x2, ..., xn, the future value is a function (1) of its previous value.

Equation 1 $x_k = f(x_{k-1}, x_{k-2}, \dots, x_{k-p})$

Adaptive Neuro-Fuzzy Inference System (ANFIS)

A fuzzy system is a system based on the logical rules of "condition-result", which using the concept of linguistic variables and the fuzzy decision process, depicts the space of input variables on the space of the output variables. The combination of fuzzy systems is based on logical rules and the method of artificial neural networks that can extract knowledge from numerical information, which has led to the introduction of a comparative nervous inference system. Figure 1 shows a fuzzy Sugeno system with two inputs, an output and two rules and an equivalent ANFIS system.



Fi. 1: a fuzzy Sugeno system with a triangular membership function and its equivalent ANFIS system (Kisi and Ozturk, 2007).

Setting time series of ferrin temperature for prediction and entering to ANFIS model in matlab with coding

In this method, the ANFIS model, for example prediction, the maximum temperature data of Ramsar station was used to obtain the membership functions generated by Genfis1, cover the entire input space. After running the required coding commands, the input membership functions of the graphs were obtained (Fig. 2).

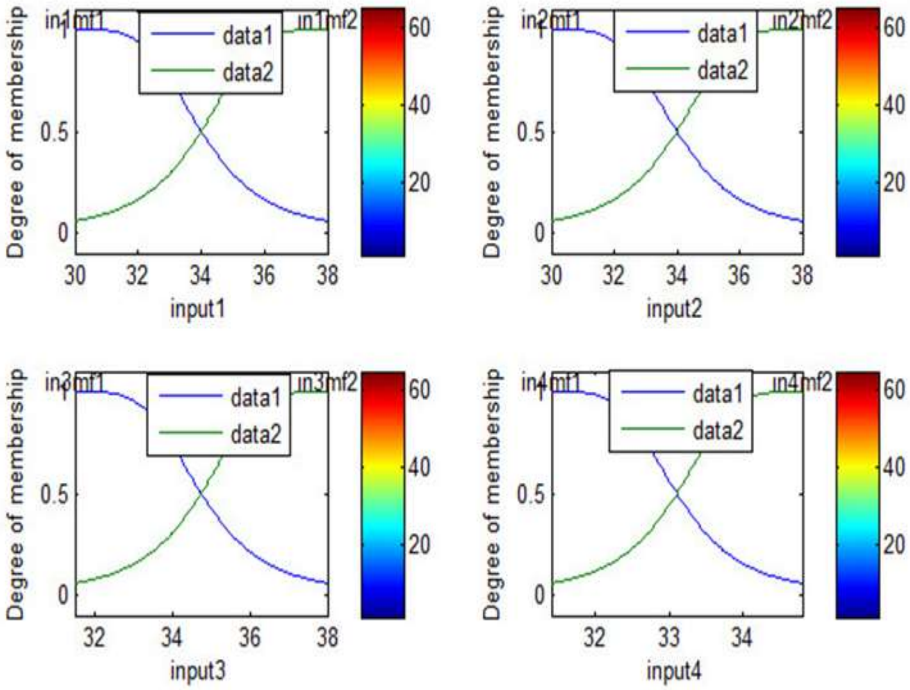


Fig. 2: the input membership functions of Ramsar Station

To start the process, the instructions and the required code were run. Since checking data were sent to this function, the final Fis corresponded to the lowest error on the checking set. The result was stored in Fismat2. By running the commands, the new membership function was plotted in graphs (Fig. 3).

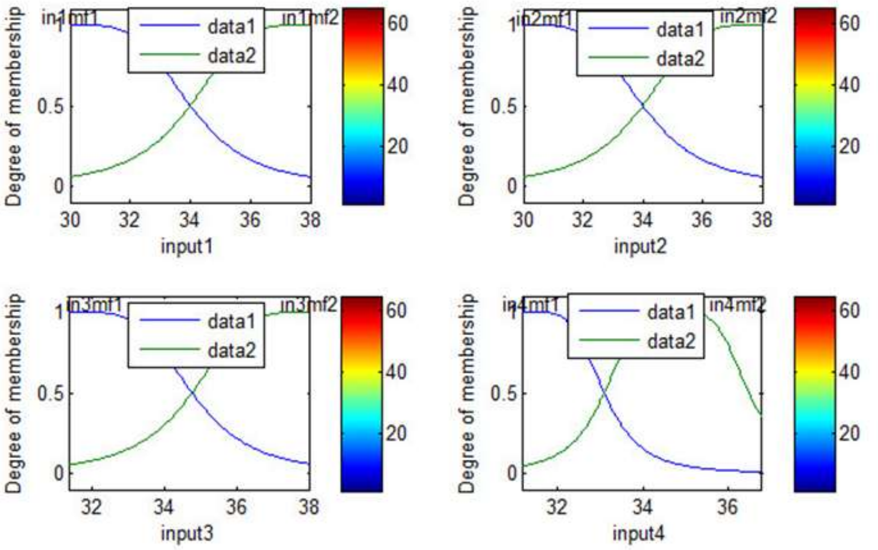


Fig. 3: The new membership function after training, Ramsar Station

The codes were also used to draw error graphs. According to Fig. 4, the root mean squared error was plotted for Ardebil station. Upper curve, is related to training errors (Error1) and the below curve is the checking data error (Error2). Table 1 shows the training errors and mean error of modeling validation (in percent) of Ramsar station. The coding command was used to obtain and set up time series and predictions as well as mean errors. In Figure 5, the predicted values for the next 6 years and the observed values are showed with green and red circle line. The predicted and observed values for Ramsar station is presented in Table 2. According to the mentioned method, the maximum temperature can be predicted using Anfis model for the studied stations and the capability of Anfis model in modeling and predicting the changes trend in mentioned time series index can be monitored and evaluated

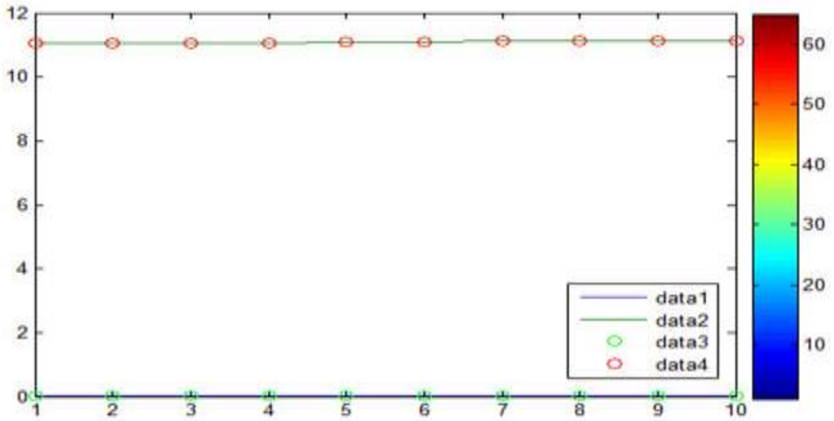


Fig. 4: Prediction Error graph of Ramsar Station

Table 1. Mean training error and mean error of modeling validation (%) of Ramsar station

mean training error	mean error of modeling validation, cheking error
0.016	15.43

Table 2. Prediction value of Ramsar station obtained from Anfis modeling (%) for the next 6 years

predicted value	Future years	Number
32.6	2019	1
31.2	2020	2
31.4	2021	3
15	2022	4
19.7	2023	5
16.5	2024	6

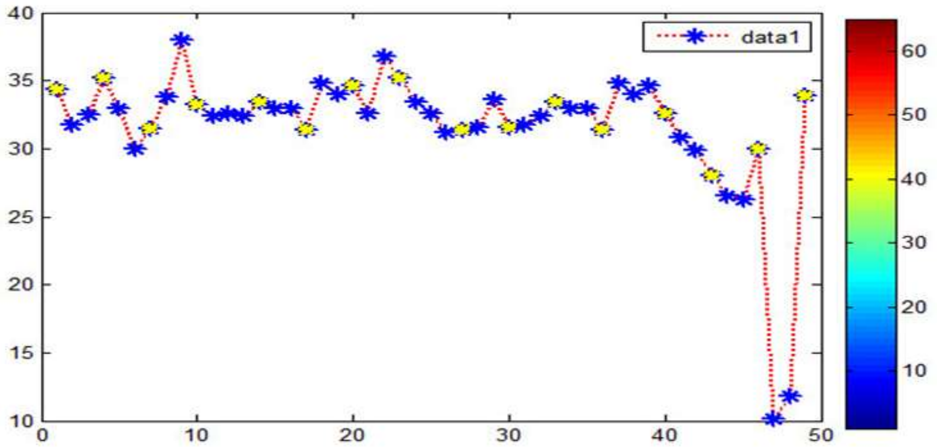


Fig. 5. Observed years and predicted years of Ramsar station for the next 6 years

RESULTS AND DISCUSSION

Predicted minimum and maximum temperatures, 3 studied stations for the next 6 years in Golestan Province

According to the modeling to predict the minimum temperature in Gorgan station, the least training error was 0.010 and for the maximum temperature, Maravetappeh had the lowest error (0.015). According to the prediction in Table 4, both maximum and minimum Ferrin temperature had an increasing trend.

Table 4. Predicted values of minimum and maximum temperature in Golestan province

minimum temperature			maximum temperature				
Gorgan	Gonbad-e Kavus	Maravetappeh	Gorgan	Gonbad-e Kavus	Maravetappeh	Predicted years	
-2.40	-0.80	-0.80	32.6	25	28	2019	1
-1.40	-0.60	-3.80	34	23.6	31.8	2020	2
-2.40	-1.60	-3.80	38.1	19	24.8	2021	3
-2.39	0.57	-0.08	17.8	15.4	17.05	2022	4
-0.71	-0.18	-0.66	10.7	13.4	11.4	2023	5
-0.38	-0.11	-0.56	17.4	3.2	2.6	2024	6

predicted minimum and maximum temperatures, 3 studied stations for the next 6 years in Gilan Province

Considering the modeling to predict the minimum and maximum temperature in Bandar-e Anzali station, the least training error was 0.010 and 0.013, respectively. According to the prediction in Table 5, both maximum and minimum Ferrin temperature had an increasing trend and the maximum temperature was more intense.

Table 5. Predicted values of minimum and maximum temperature in Gilan province

minimum temperature			maximum temperature				
Bandar-e Anzali	Astara	Rasht	Bandar-e Anzali	Astara	Rasht	Predicted years	
0/80	−1/80	−2/40	36	32/2	26	2019	1
−0/40	−1/20	0	21	33/2	29.6	2020	2
4/80	−2/20	0/20	21/4	32/8	30/5	2021	3
−0/78	−0/97	−0/33	13/1	9/6	5/4	2022	4
−0/07	−1/33	0	3/9	4/5	6/4	2023	5
0/18	−0/59	0/72	11/9	7/4	3/9	2024	6

Predicted Minimum and Maximum Temperatures, 3 studied stations for the next 6 years in Mazandaran Province

According to the modeling to predict the minimum temperature in Babolsar station, the least training error was 0.019 and for the maximum temperature, Ramsar had the lowest error (0.015). According to the prediction in

Table 6, both maximum and minimum Ferrin temperature had an increasing trend and the minimum temperature showed a higher intensity.

Table 6. Predicted values of minimum and maximum temperature in Mazandaran province

minimum temperature			maximum temperature				
Ramsar	Nowshahr	Babolsar	Ramsar	Nowshahr	Babolsar	Predicted years	
1	−0/20	2/50	32/6	30/8	24/4	2019	1
−0/60	0	1/60	31/2	30/6	28/2	2020	2
1/80	1/60	−0/60	31/4	30/6	33/2	2021	3
−0/03	0/58	0/26	15	12/8	23/8	2022	4
−0/26	0/54	0/02	19/7	7/41	6/8	2023	5
0/07	0/36	−0/01	16/5	27/9	3/9	2024	6

Land prioritization for feasibility of cultivation with minimum temperature criterion based on VIKOR model

The VIKOR model was used to rank stations in terms of minimum temperature for selecting suitable and unsuitable places for cultivation in the next 6 years. The top three stations for cultivation were Gonbad-e Kavoos, Astara and Maravetappeh with priority rate of 1.219, 0.993 and 0.990, respectively and the worse three stations were Ramsar, Babolsar and Bandar-e Anzali with priority rate of 0.001, 0.026 and 0.109, respectively (Fig. 7, Table 7).

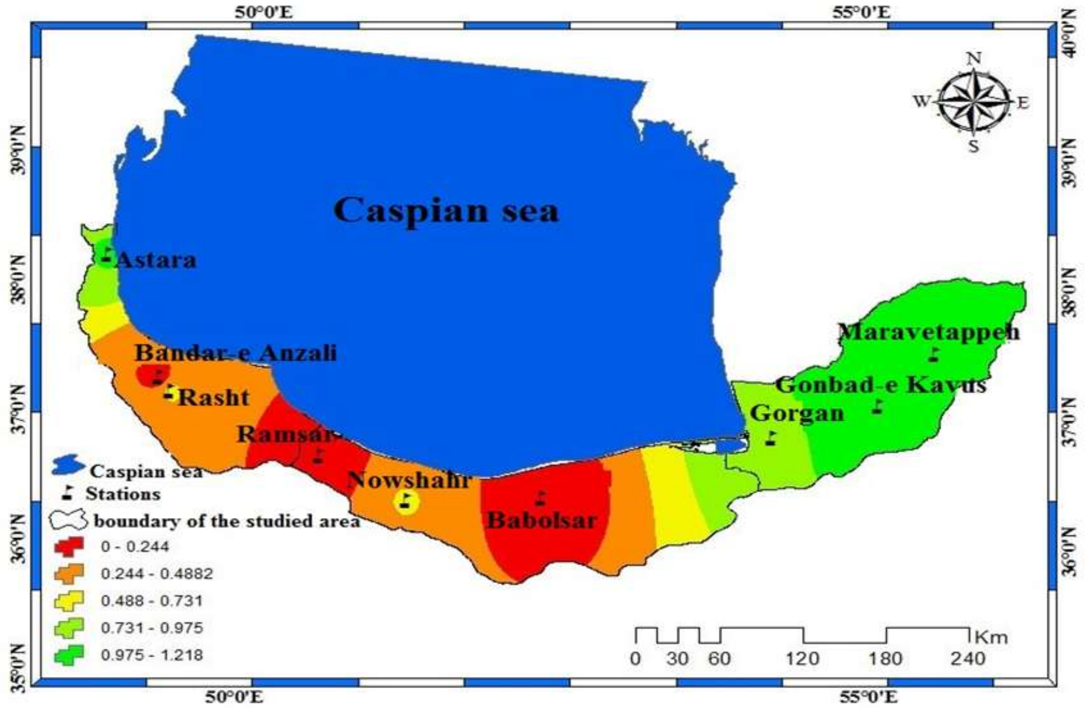


Fig. 7. Final map of areas susceptible to cultivation with the minimum temperature criterion in the north bar of Iran based on the VIKOR model

Table 7. Prioritization of stations based on minimum temperature in the VIKOR Model

Rank	score	Stations
9	0/001	Ramsar
6	0/501	Nowshahr
8	0/026	Babolsar
2	0/993	Astara
7	0/109	Bandar-e Anzali
5	0/551	Rasht
4	0/952	Gorgan
1	1/219	Gonbad-e Kavoos
3	0/990	Maravetappeh

Land prioritization for feasibility of cultivation with maximum temperature criterion based on VIKOR model: Considering the importance of VIKOR model, the maximum temperature of the stations was also evaluated. Suitable and unsuitable places for cultivation in the next 6 years were studied in terms of maximum temperature. The top three stations for cultivation were Maravetappeh, Gonbad-e Kavoos and Gorgan with priority rate of 1.160, 1.106 and 1, respectively and the worse three stations were Nowshahr, Rasht and Astara with priority rate of 0, 0.057 and 0.215, respectively (Figure 8, Table 8).

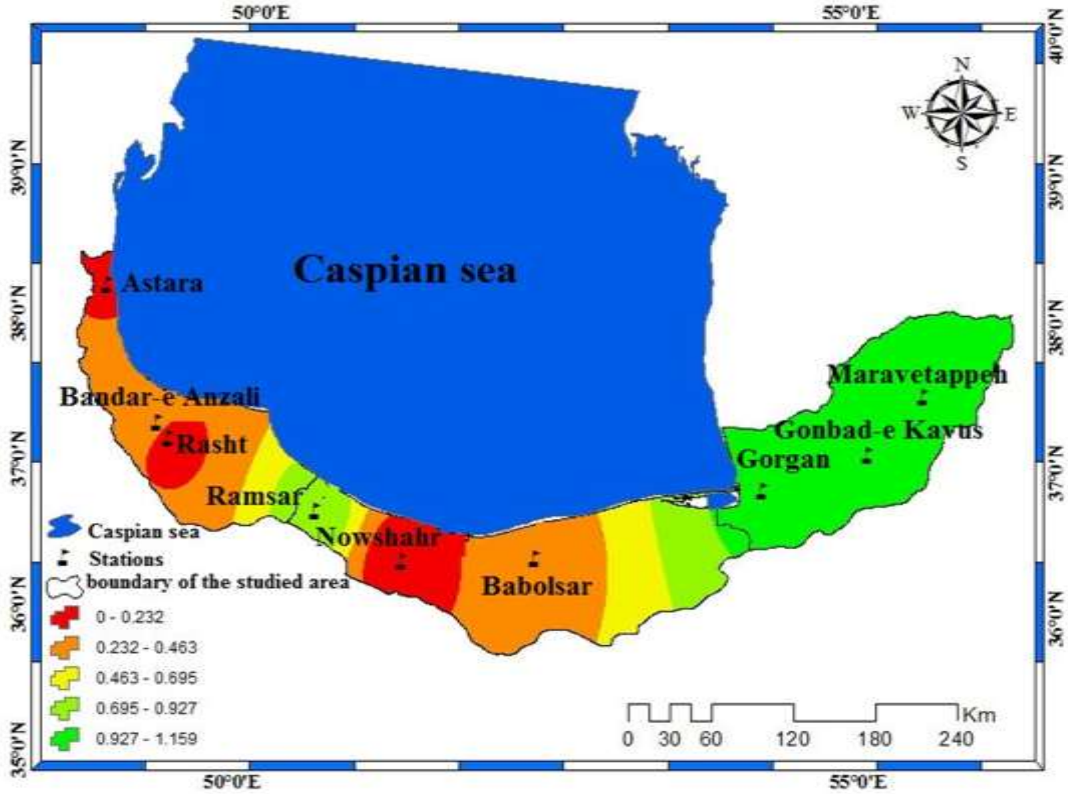


Fig. 8: Final map of areas susceptible to cultivation with the maximum temperature criterion in the north bar of Iran based on the VIKOR model

Table 8: Prioritization of stations based on maximum temperature in the VIKOR model

Rank	score	Stations
4	0/911	Ramsar
9	0	Nowshahr
6	0/340	Babolsar
7	0/215	Astara
5	0/433	Bandar-e Anzali
8	0/057	Rasht
3	1	Gorgan
2	1/106	Gonbad-e Kavoos
1	1/160	Maravetappeh

Land prioritization for feasibility of cultivation with minimum temperature criterion based on TOPSIS model

The capability of areas along the north bar of Iran in terms of agricultural and horticultural cultivation was studied using the Topsis model. Results of running Topsis model using the degree of importance of the criteria derived from the entropy method were studied. suitable and unsuitable places for cultivation in the next 6 years were studied in terms of minimum temperature. The top three stations for cultivation were Gonbad-e Kavoos, Gorgan and Rasht with priority rate of 0.728, 0.722 and 0.610, respectively and the worse three stations were Bandar-e Anzali, Ramsar and Astara with priority rate of 0, 0.057 and 0.215, respectively (Fig. 9, Table 9).

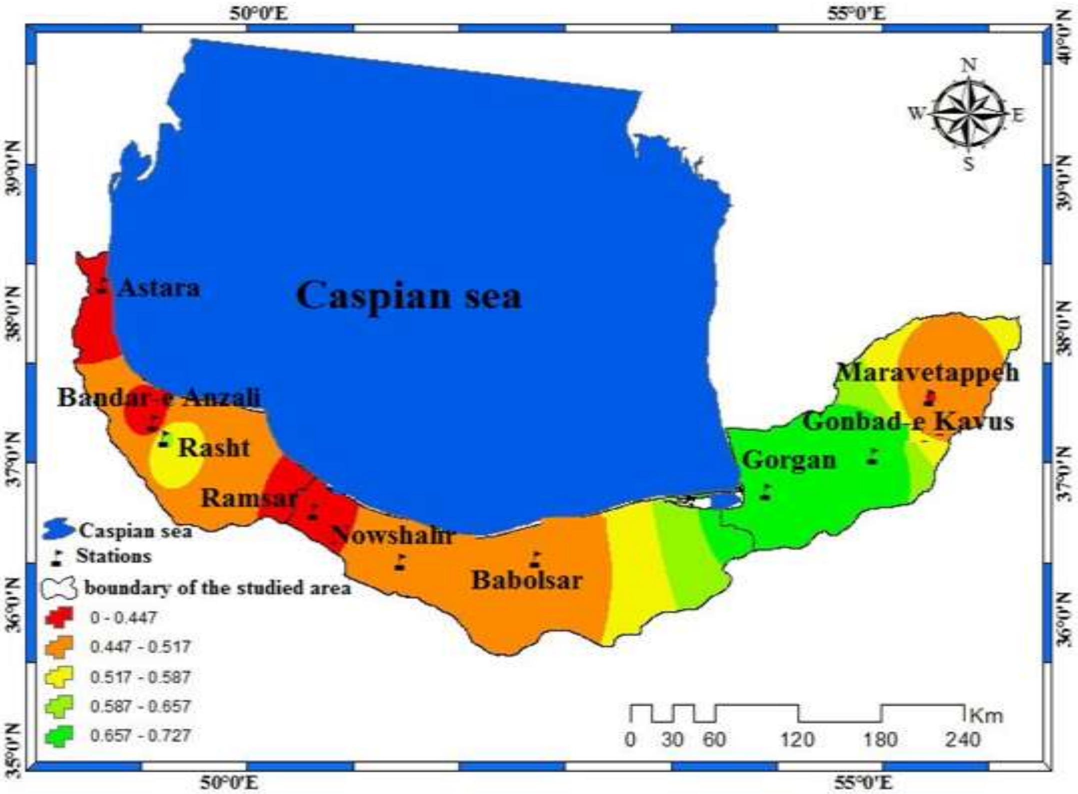


Fig. 9: Final map of areas susceptible to cultivation with the minimum temperature criterion in the north bar of Iran based on the Topsis model

Table 9. Prioritization of stations based on minimum temperature in the TOPSIS model

Rank	score	Stations
8	0/408	Ramsar
4	0/507	Nowshahr
5	0/477	Babolsar
7	0/415	Astara
9	0/377	Bandar-e Anzali
3	0/610	Rasht
2	0/722	Gorgan
1	0/728	Gonbad-e Kavoos
6	0/446	Maravetappeh

Land prioritization for feasibility of cultivation with maximum temperature criterion based on TOPSIS model

Considering the importance of the Topsis model, the parameter of maximum temperature of stations were also evaluated, which suitable and unsuitable places for cultivation in the next 6 years were studied in terms of maximum temperature. The top three stations for cultivation were Gorgan, Astara and Maravetappeh with priority rate of 0.791, 0.727 and 0.559, respectively and the worse three stations were Nowshahr, Rasht and Ramsar with priority rate of 0, 0.057 and 0.215, respectively (Fig. 10, Table 10).

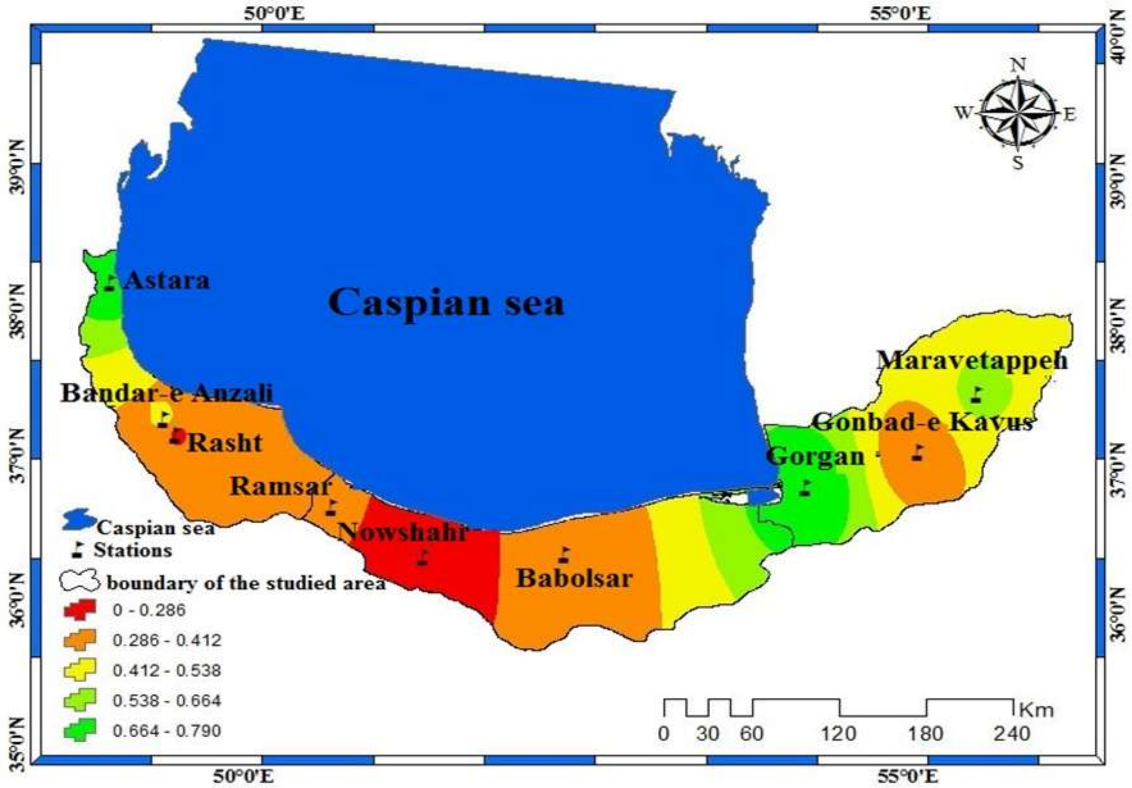


Fig. 10: Final map of areas susceptible to cultivation with the maximum temperature criterion in the north bar of Iran based on the Topsis model

Table 10: Prioritization of stations based on maximum temperature in the TOPSIS model

Rank	score	Stations
7	0/302	Ramsar
9	0/160	Nowshahr
5	0/341	Babolsar
2	0/727	Astara
4	0/447	Bandar-e Anzali
8	0/266	Rasht
1	0/791	Gorgan
6	0/305	Gonbad-e Kavoos
3	0/559	Maravetappeh

In recent years, damage to horticultural and agricultural products caused by Ferrin temperature has incresed. Accordingly, the prediction of hazardous effects of monthly Ferrin temperature on horticultural and agricultural products in the north bar of Iran was investigated in this study. After collecting monthly data, their analyzes, modeling and prediction were done using the adaptive neuro-fuzzy inference system (Anfis). After error detection, the data was predicted for Ferrin temperature of the next six years. The two multivariate decision making models of Vikor and Topsis were used to prioritize lands for cultivating. Regarding the error detection modeling of Ferrin temperature, the least error was obtained for the maximum temperature compared to the minimum temperature. Regarding the obtained errors, with high confidence, Ferrin temperatures were predicted for the next six years. Based on the predicted data, the minimum temperature at Gorgan station had the lowest training error with the value of 0.010 and the maximum temperature at Maravetappeh station had the lowest error of 0.015. Finally, both maximum and minimum Ferrin temperatures in Golestan province were weak at increasing trend. Minimum and maximum temperature at Bandar-e Anzali station had the lowest training error with the value of 0.013 and 0.010, respectively. In Gilan province, both maximum and minimum Ferrin temperature had an increasing trend and the maximum temperature was more intense. The minimum Ferrin temperature at Babolsar station had the lowest training error of 0.019 and the maximum temperature at Ramsar station had the lowest error of 0.016. In Mazandaran province, maximum and minimum Ferrin temperature were both more intense at increasing trend. The results of land prioritization for feasibility of cultivation of agricultural and horticultural products for the next six years based on Vikor model, after checking the stations in terms of maximum and minimum temperature, two stations of Maravetappeh and Gonbad-e Kavoos allocated the highest priority. However, a common station did not placed in worse ranked stations. Six stations including Ramsar, Babolsar, Bandar-e Anzali, Nowshahr, Rasht and Astara had the worse scores for cultivation. Based on TOPSIS model, Gorgan station as the common station assigned the highest priority in terms of maximum and minimum temperature. However, Ramsar station became the worst common station for cultivation

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