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Climate Change Assessment in Gilan province, Iran

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ABSTRACT: Climate change impacts have been studied on precipitation, minimum and maximum temperature, Numbers of wet and dry day, Numbers of frost and hot day for future period (2011-2030) by LARS-WG stochastic weather generator over Gilan province in Iran. It was produced synthetic series of daily of rainfall, Numbers of wet day and Numbers of frost day will be decreased during the 2011-2030 periods. The amounts of decreasing were 15.2 mm, 11 days and 5 days precipitation, radiation, minimum and maximum temperature of 8 selected synoptic stations in and outside of Gilan province. Statistical tests concluded that synthetic data were significantly identical to the observed values. Results showed that LARS-WG has a reasonable capability of simulating for the future. It was used the outputs from 2 GCMs models (MPEH5, HADCM3) based on 2 scenarios (A_2, B_1) were used for preparing the future data. It has chosen results of their comparison and MPEH5 model based on A_2 scenario as a suitable model for predicting the future. It was shown predicting of MPEH5 model that annual amount respectively. It will be increased the amount of minimum and maximum temperature, Numbers of dry day and Numbers of hot day.
Keywords: Climate change, GCMs models, LARS-WG, Gilan province.

INTRODUCTION

It has been caused most of the warming over the past 50 years by emissions of carbon dioxide (CO2) and other 'greenhouse gases' as a result of human activities (IPCC, 2007; Ragab & Prudhomme, 2002; Freiwan & Kadioglub, 2008). According to the current trend, climate change is inevitable. It has most important in agriculture aspect, because the agricultural section provides food for people and climate change influence the safety food.

The General Circulation Model (GCM) is the most current method by using in climate change studies. They are a key to understanding changes in climate; Although GCMs are imperfect and uncertain.

Output from GCMs requires application of various downscaling techniques (Barrow et al. 1996, Bardossy 1997, Wilby et al. 1998, Mearns et al. 1999, Murphy 1999, Salon et al. 2008). One of the downscaling techniques to create daily site-specific climate scenarios makes use of a stochastic weather generator (WG; Wilks 1992, Barrow & Semenov 1995, Wilks & Wilby 1999, Semenov 2007). Recently have been used weather generators in climate change studies to produce daily site-specific scenarios of future climate (Wilks 1992, Mearns et al. 1997, Semenov & Barrow 1997).

Two important reasons for using LARS-WG model include the provision of a means of simulating synthetic weather time-series with certain statistical properties which are long enough to be used in an assessment of risk in hydrological or agricultural applications and providing the means of extending the simulation of weather time-series to unobserved locations. In fact, LARS-WG has been used in various studies, including the assessment of the impacts of climate change (Barrow & Semenov, 1995; Semenov & Barrow, 1996; Weiss et al., 2003; Lawless & Semenov, 2005; Khan et al., 2006; Scibek & Allen, 2006; Semenov, 2007; Semenov & Doblas, 2007; Dubrovsky, 1996).

It can be divided the process of generating synthetic weather data into three distinct steps as follows; 1.Model Calibration, 2.Model Validation, and 3.Generation of Synthetic Weather Data (Zhang & Garbrecht, 2003; Nakicenovic & Swart, 2000).

They are studied Changes in the climate variables in Gilan Province located in north of Iran. It was compared the output from two GCM models with a stochastic weather generator. In this study LARS-WG and suitable GCM model used to produce a climate change scenario.

MATERIALS AND METHODS

Study area

The study area is Gilan Province of Iran, which situated in the north of Iran and located in the South of Caspian Sea and has about 14044 kilometers extent area. Location of longitude is between 48 degrees 53 minutes and 50 degrees 34 minutes and latitude is between 36 degrees 34 minutes and 38 degrees 27 minutes (Fig 1). It has the best type of weather and climate in Iran with a moderate and humid climate that is known as the moderate Caspian climate. The effective factors on such climate include the Alborz mountain range, direction of the mountains, the height of the area, and the Caspian Sea, vegetation surface, local winds, as well as the altitude and weather fronts. As a result of the above factors mentioned, there are three different climates in the region as follows:

1. Plain moderate climate with an average annual rainfall amounts to 1300 mm, which decrease to the east.
2. Mountainous climate which covers the high mountains and northern parts of the Alborz range that weather is cold mountainous and most of the precipitation is in the form of snow.
3. Semi-arid climate with the average annual rainfall about at 500 mm: Also the average annual temperature is 18.2°C.

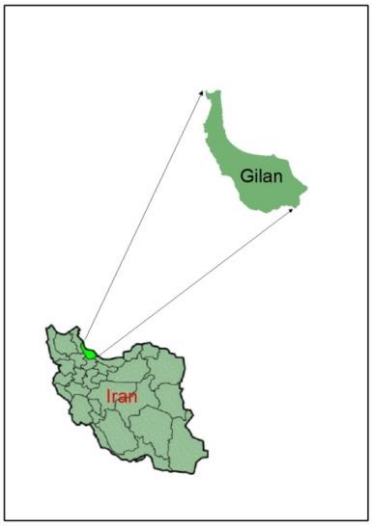

Figure 1. Study area location

METHODS

It was statistically evaluated the performance of the LARS-WG stochastic weather generator model by comparing the synthesized data with climatology period at 8 selected synoptic stations, based on 2 GCMs models (MPEH5, HADCM3) and 2 scenarios (A2, B1). It has shown the period of base data contained precipitation, minimum and maximum temperatures and solar radiation from 1992 to 2010 in this study. Name, latitude and longitude coordinates, as well as the elevation of the synoptic stations in Table 1. Firstly, LARS-WG model was done based on the historical climate data obtained from 1992-2010 for verification of the model. The model was done after assessing the model ability in each station for all 4 states (2 GCMs models based on 2 scenarios). Then the results were compared and the best model was chosen for evaluating the climate change in the study area.

Table 1. Synoptic stations utilized in the study

Stations	Latitude (°N)	Longitude (°E)	Elevation (m)
Anzali	37.29	49.27	-23/6
Ardebil	38.15	48.17	1332
Astara	38.22	48.51	-21/1
Ghazvin	36.15	50.3	1279/2
Manjil	36.44	49.25	338/3
Ramsar	36.54	50.4	-20
Rasht	37.19	49.37	-8/6
Zanjan	36.41	48.29	1663

RESULTS AND DISCUSSION

Model validation is one of the most important steps of the process. The objective was to assess the performance of the model in simulating climate at the chosen site to determinate whether or not it is suitable for using. Firstly, LARS-WG model was done based on the historical climate data obtained from 1992-2010 for verification of the model. A large number of years of simulated daily weather data were generated and were compared with observed data by using the t test. Fig 2 typically represents the comparison between synthetic and observed data in Rasht Station. The mean monthly correlation of the precipitation, minimum and maximum temperature and solar radiation were acceptable in 0.05 level of confidence.

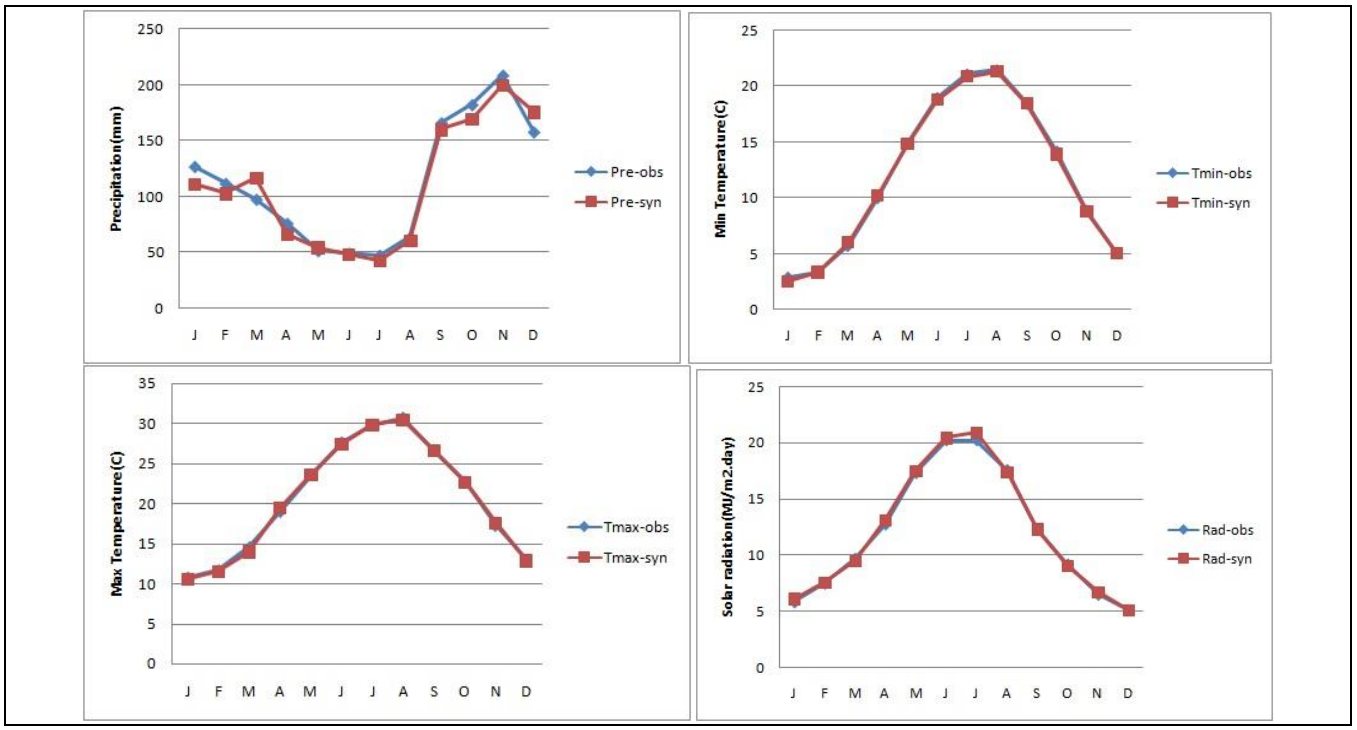

Figure 2. Comparison between synthetic and observed data in Rasht Station

Then was performed for selecting the suitable GCM model, LARS-WG stochastic weather generator model for MPEH5 and HADCM3 models in A2 and B1 scenarios. It was shown in fig 3, between these 4 states, MPEH5 model based on A2 scenario that has the least difference with the models mean has selected and used for predicting the future climate.

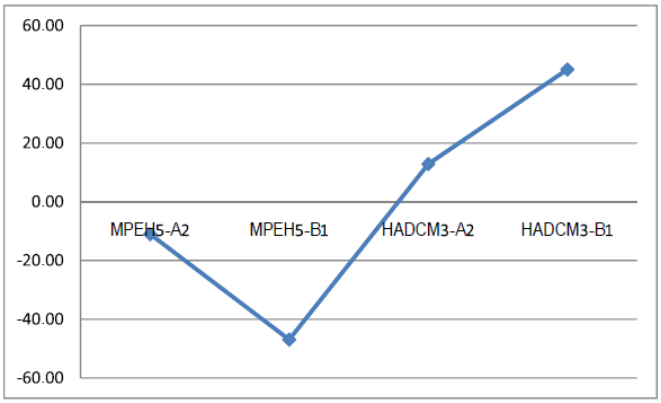

Figure 3. Comparison between 2 models based on 2 scenarios

Finally, it compared produced data based on selected model during 2011-2030 with the observed data during 1992-2010 for evaluating the changes between 2 periods. It has shown differences between climatic parameters in 2 periods in figs 4 to 10.

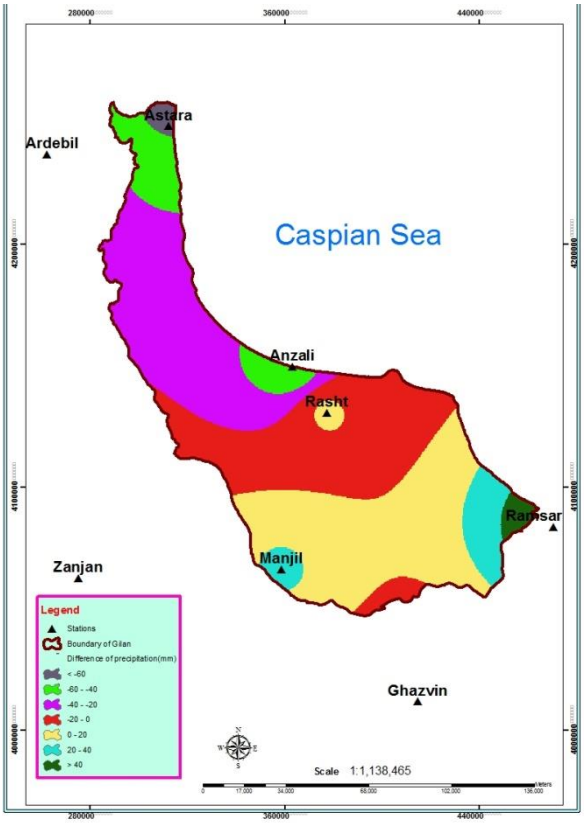

Figure 4. Precipitation differences in the 2 periods.

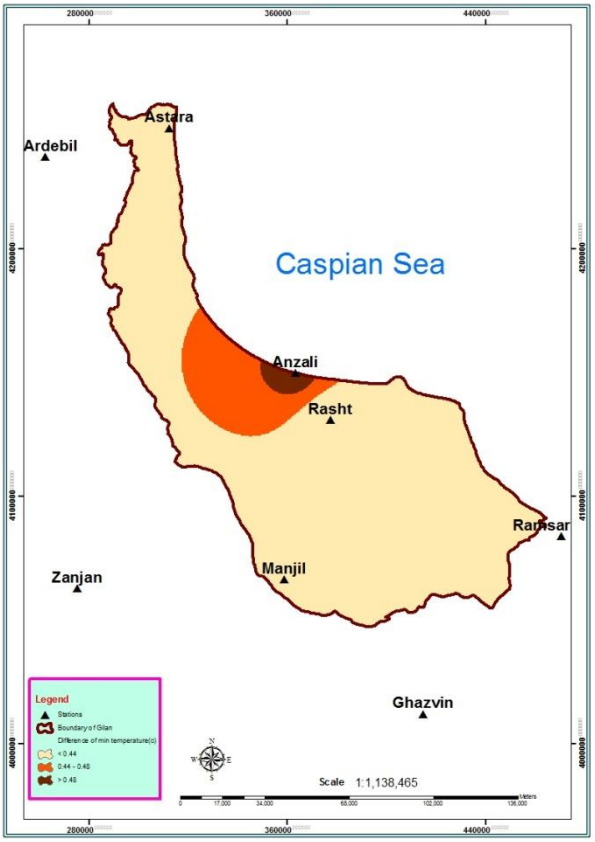

Figure 5. Minimum temperature differences in the 2 periods.

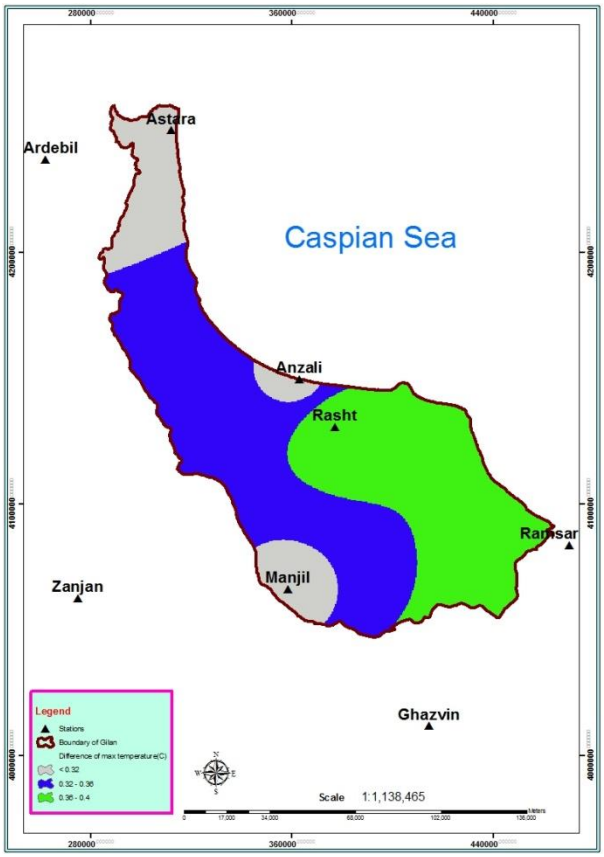

Figure 6. Maximum temperature differences in the 2 periods.

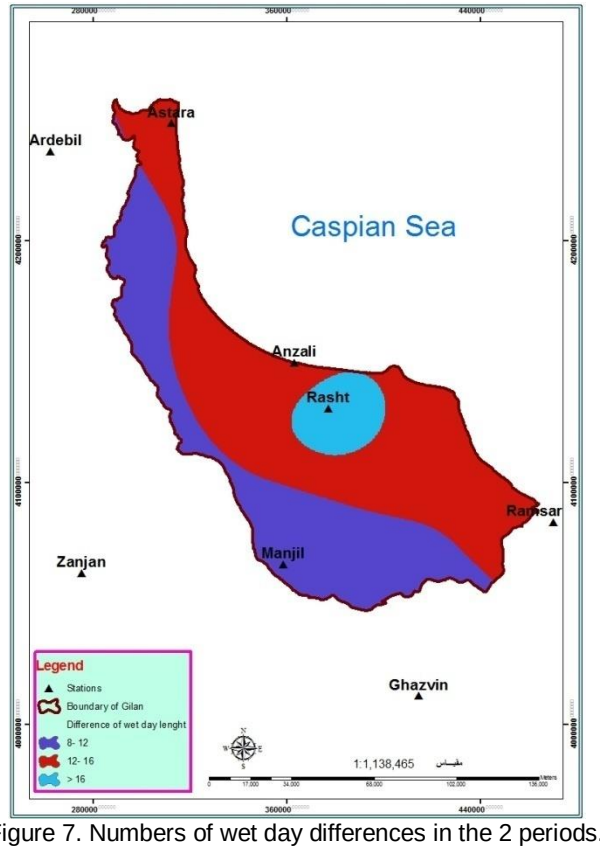

Figure 7. Numbers of wet day differences in the 2 periods.

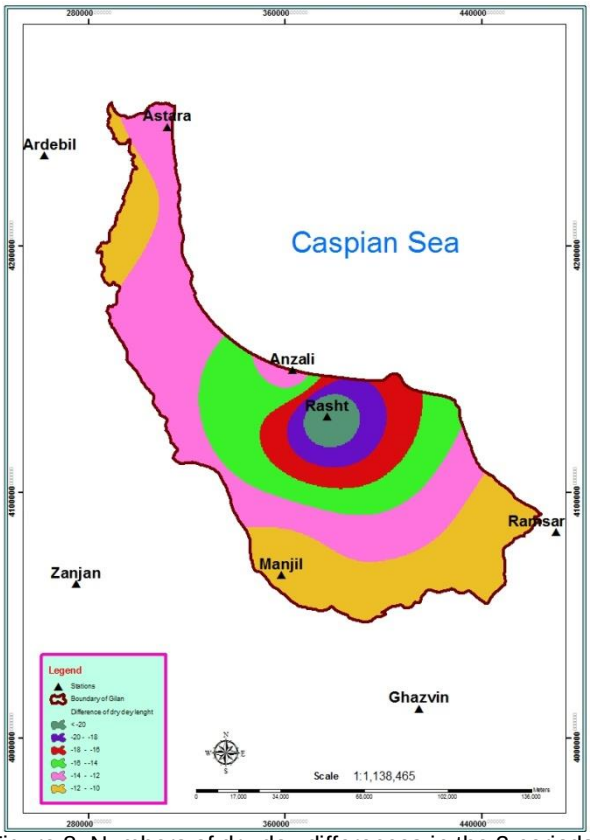

Figure 8. Numbers of dry day differences in the 2 periods.

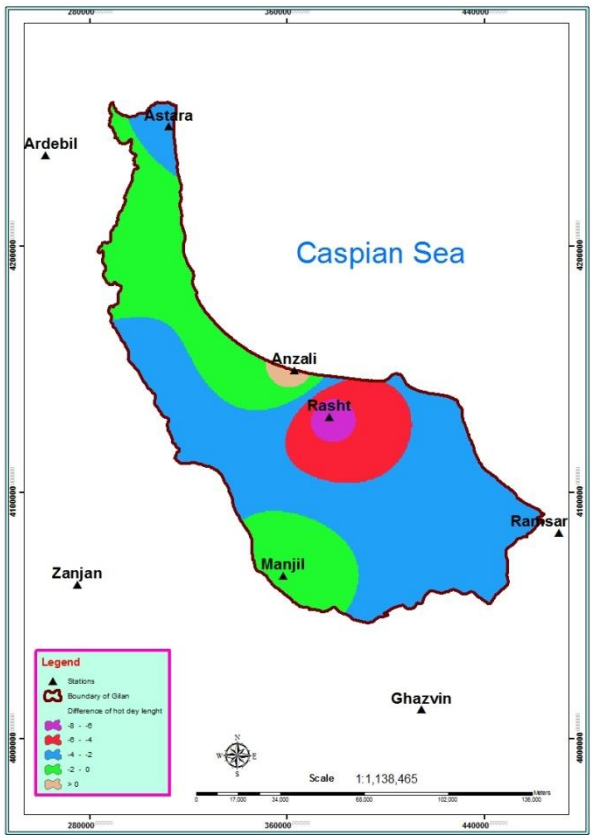

Figure 9. Numbers of hot day differences in the 2 periods.

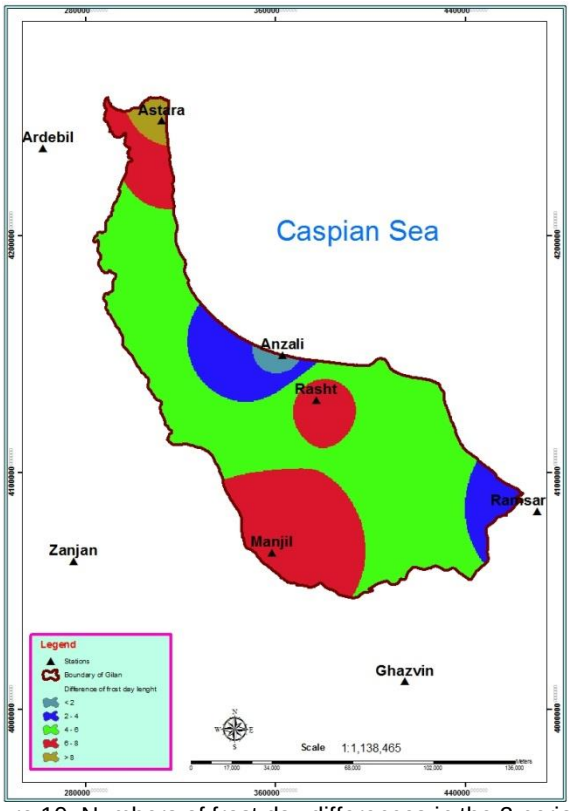

Figure 10. Numbers of frost day differences in the 2 periods.

CONCLUSION

Research results showed that mean of precipitation in Gilan province has decreased during 2011-2030. The mean of precipitation has estimated 15.2 mm. Precipitation has decreased in the most parts of study area. It has been related to Astara the most decreasing in precipitation. The precipitation has increased in the south and west of Gilan province including Langerood, Amlash, Ramsar, Roodbar and parts of siahkal that the most of increasing has been in the boundary of Gilan with Mazandaran. Precipitation in other months has decreased except February, March, August and November that the most of decreasing has been in September.

It has increased the minimum temperature of study area that the most increasing is in Anzali with having 0.5 ºC. Generally the mean of minimum temperature in study area has decreased during 2011- 2030 that its amount having 0.4 ºC. The most of changes has been in winter and spring that the minimum temperature has increased in these times. The most increasing has happened in the month of May amount with having 1.9 ºC.

It has increased the maximum temperature of Gilan province with having 0.4 ºC and the most of changes has been in the east of study area. Most of changes have happened in April and May that the maximum temperature has increased in these months about 1.2 ºC.

It has decreased numbers of wet day (days with precipitation more than 0.1 mm) that the most of decreasing has happened in Rasht. It has been the least of decreasing in mountainous areas. It has been decreasing of numbers wet day in the plain of Gilan more than mountainous areas. Numbers of decreasing in wet day has been 11 days. The most of decreasing has happened in October with 4 days.

It has increased numbers of dry day length (days with precipitation less than 0.1 mm) that amount of it was 12 days. The most of changes has happened in Rasht and the difference between 2 periods has decreased toward around areas. It has been increased numbers of dry day except April, which the most of increasing is in October by 4 days.

It has increased numbers of hot day (days with maximum temperature more than 30 ºC) 3 days that the most of increasing has happened in Rasht. Except Anzali and Astara, numbers of hot day has decreased in other places. The most of increasing has been in July by 2 days.

It has decreased during 2011- 2030, numbers of frost day (days with minimum temperature equal or less than 0 ºC) 5 days. The most of decreasing has happened in Astara, Rasht, Roodbar and the south of Talesh. The least changes have been in Anzali. It has increased despite of decreasing in the numbers of frost day in Gilan, in November and December. It has decreased in other months that the most of it has been in October by 3 days.

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