

# Evaluation of the Climatic Parameters Trend Changes in North of IRAN (Mazandaran Province) Using Synoptic Stations Data of the Region

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Available online at: [www.isroset.org](http://www.isroset.org)

Received: 16/Sept/2022, Accepted: 19/Nov/2022, Online: 31/Dec/2022

**Abstract**—In this study, in order to investigate the phenomenon of climate change in Mazandaran province, the statistics of 4 important synoptic stations of the region have been used. Considering the importance of meteorological parameters of temperature and rainfall in climate change studies, the most important characteristics affecting these factors include average daily sunshine hours, daily rainfall, average daily temperature, average maximum daily temperature and average minimum daily temperature in selected stations in terms of trends and their changes during the available statistical time periods of the stations were investigated and researched. According to the trend curve of sunshine hours, it is clear that there are large fluctuations in the average. On the other hand the results about all synoptic station have shown large fluctuations in the rainfall recorded at all station. So that as we get closer to the present time, these changes have witnessed more fluctuations. The temperature fluctuations of all stations, which have been examined daily, have shown large temperature changes in the area of all synoptic station. It is worth mentioning that the closer we get to the present time, the better we see temperature changes and temperature increases. The examination of the average maximum and minimum temperature also confirms the large changes of these two parameters in this area and confirms the impact of the climate change phenomenon in this area. Considering that this province is one of the poles of rice production in the country, and on the other hand, in terms of other agricultural products and various citrus fruits that are grown in this area, we will see many changes in these products in the future, so that if careful planning. If it is not done to deal with the harm effects of climate change in the study area and other areas, it can have destructive effects on the agriculture of the area..

**Keywords**- Climate Change, Climatic Parameters, Synoptic Stations, Mazandaran province

## I. INTRODUCTION

The Fifth Assessment Report states that warming of the climate system is evident. The atmosphere and oceans are warming, snow and ice are melting, sea levels are rising, and greenhouse gas concentrations are rising. The report says that the greatest cause of the observed warming is an increase in atmospheric carbon dioxide, and that it is "very likely" that human influence has increased since the mid-20th century (Stocker et al., 2013). These changes and projected future ones pose risks to human and natural systems and can have catastrophic consequences if left unchecked. The main reasons for concern are: Threats to native ecosystems and cultures. Increased occurrence of extreme weather events. Disproportionate impact on disadvantaged communities. Global impacts on biodiversity and the economy. Risk of large single events such as ice sheet loss (Field et al., 2014). Human-induced climate change (e.g. impacts on global mean temperature, sea level, extreme precipitation, etc.) (Christensen et al.2004; Davidson, Janssens. 2006; Diabat et al. 2013; Safeeq

and Fares. 2012; Tian et al. 2013). Observed global warming over the past decades has been consistently associated with changes in the water cycle and many components of the water system. Changes in precipitation patterns, intensity and extremes. widespread melting of snow and ice; increased atmospheric water vapor; increased evaporation; changes in soil moisture and runoff. On timescales of years to decades, all components of the hydrological cycle have significant natural variability, often masking long-term trends. Due to large regional variations and the limited spatial and temporal coverage of monitoring networks, there remains considerable uncertainty regarding trends in hydrological variables (Huntington, 2006).

Currently, documenting annual variability and trends in precipitation over the ocean remains a challenge. [WGI 3.3] Understanding and identifying the causes of observed changes is also a challenge. For hydrological variables such as runoff, non-climate-related factors may play a significant role locally. (e.g. changes in abstraction). The reaction of climate to blowing agents is also complex. For example, one effect of absorbing an aerosol (such as soot)

is to trap heat that would otherwise reach the surface in the aerosol layer, promoting evaporation and subsequently releasing latent heat across the surface. Therefore, absorbing aerosols can locally reduce evaporation and precipitation. Many aerosol processes are either omitted from climate models or accounted for in relatively simplistic ways, and the local magnitude of their effects on precipitation is in some cases poorly known. Despite the uncertainties above, many statements can be made about the assignment of observed hydrological changes contained in the discussion of individual variables in this section, based on the AR4 assessment. . [WGI 3.3, 75.2, 8.2.1, 8.2.5, 9.5.4; WGII 3.1, 3.2]

## II. METHODOLOGY

Mazandaran is located on the southern shore of the Caspian Sea. Clockwise, it borders the provinces of Golestan, Semnan, and Tehran. The state also borders Qazvin and Gilan to the west. Mazandaran province is geographically divided into two parts he of the coastal plain and the mountainous area. The Alborz Mountains surround the plains bordering the coastline and the Caspian Sea like a giant wall. On the southern and eastern coasts of the Caspian Sea, sea breezes and localized winds prevail, resulting in the formation of sand dunes, creating a low natural barrier between the sea and the plains. The Alborz region, which runs parallel to the southern shore of the Caspian Sea, gets a lot of snow and divides the province into many isolated valleys. The state enjoys a mild subtropical climate with an average summer temperature of 25°C and an average winter temperature of around 8°C. In winter, the mountains can get a lot of snow, but the ocean rarely snows. Mazandaran province is influenced by latitude, the Alborz mountains, altitude above sea level, distance from the sea, barren areas in southern Turkmenistan, local and regional air currents, and diverse vegetation. These conditions divide the state's climate into three types: (1) a temperate Caspian climate with hot, humid summers and mild, wet winters, and (2) a temperate mountainous climate with long, cold, freezing winters and mild, short summers. and (3) a cold mountain climate, with long, freezing winters and short, cool summers. The latter region has snowfall for most of the season, lasting well into midsummer. The western and central plains of the state to the northern foothills of the Alborz Mountains enjoy the mild climate of the Caspian Sea region. At altitudes between 1,500 and 3,000 meters, the mountainous climate is mild, with long, cold winters and short, mild summers. In this region, parts of the state are covered in snow even in the middle of the warm season. In fact, the region sees snow even during the hottest months of the year. Figure (1) shows the location of the surveyed synoptic stations in Mazandaran province, Iran, and Figure (2) shows the map of the surveyed synoptic stations in Mazandaran province, Iran.

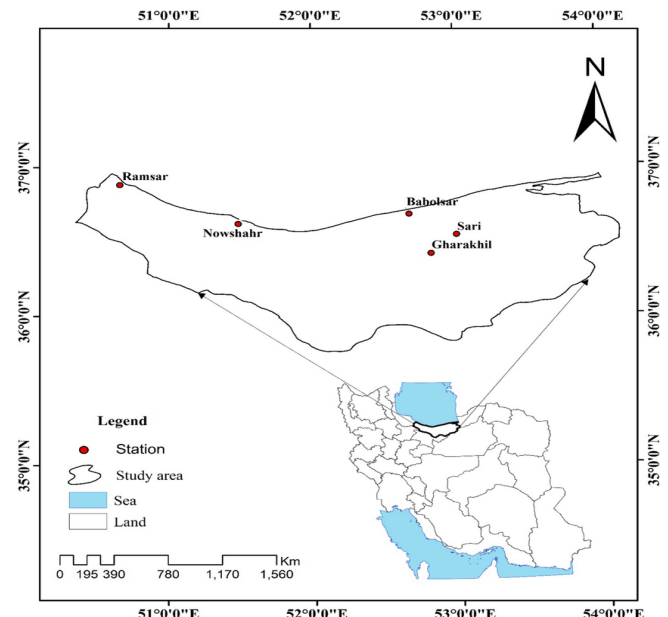
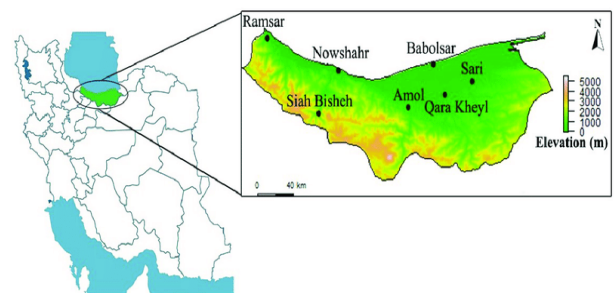


Figure (1): Mazandaran-province-in-Iran-and-the-location-of-studied-synoptic-stations



Figure(2): The-map-of-the-investigated-synoptic-stations-in-Mazandaran-province-Iran.

### Synoptic weather station:

The Synoptic Weather Station monitors the weather at synoptic time 00:00, 06:00, 12:00, 18:00 (UTC) and synoptic time 03:00, 09:00 in between. A device that provides information. , 15:00, 21:00 (UTC) Collected. Common measuring instruments are anemometers, wind vanes, pressure sensors, thermometers, hygrometers and rain gauges. Weather measurements are formatted in a special format and sent to WMO to support weather forecast models. The Synoptic Weather Station is to simultaneously measure and process atmospheric parameters around the world in accordance with the rules and regulations of the World Meteorological Organization 24 hours a day and transmit after 3 hours via a telecommunications network called Sinop and after 1 hour It is a station that is obliged to time. They are called matar and come in many different types depending on their use. Overview Stations: 1- Main Station 2- Auxiliary Station 3- Airport. In Iran these are the main weather stations affiliated with the Meteorological Agency. These stations measure hourly and daily statistics about temperature, precipitation, relative humidity, wind, evaporation, and other meteorological variables. Based on the characteristics of temperature and precipitation, as well as

the topography of the region, Mazandaran province can be divided into two types: Caspian temperate climate and mountain climate. Its mountainous climate consists of two types: temperate mountainous climate and cold mountainous climate.

#### First Caspian Temperate Climate:

This climate type covers the western and central plains of the state to the northern foothills of Alborz. Due to the short distance between the mountains and the sea, moisture can accumulate in these areas, resulting in significant rainfall and moderate temperatures. The average annual rainfall in the coastal zone of the state is 977 mm. Its spatial distribution decreases from west to east, but its temporal distribution is fairly regular (the maximum rainfall occurs in autumn and the minimum in spring). When examining the temperature parameters, we observed that moderate air temperature and temperature range were limited due to high relative humidity and frequent cloudy days. This results in hot and humid summers and occasional frosts in winter.

#### 2-a) Mild mountainous climate:

The climate of the province undergoes a special change as the altitude rises gradually from the plains to the northern slopes of the Alborz plateau and away from the sea. Mountain climatic conditions prevail between 1500 and 3000 meters above sea level, characterized by reduced annual rainfall and lower average monthly temperatures. The climate is also characterized by cold winters with long frosts and short summers.

#### 2-b) Cold Mountain Climate:

Above 3,000 meters above sea level, including the peaks of the northern slopes of Alborz, temperatures drop sharply and long frosts occur. In these areas, precipitation, often in the form of snow, accumulates during the long cold period of the year and lasts into the middle of the short warm period. In these areas and the summits of the Damavand Range, Alam Khu and Takhte Soleyman, conditions were created for the formation of mountain glaciers, and the permanent accumulation of snow in the coastal areas of the Caspian Sea led to the loss of glaciers. It benefits year-round from the climatic influences of its neighbors: the vast lands of Siberia, the Mediterranean and Caspian Seas, and the central plateau of Iran. Several air masses enter the state at different times of the year, the most important of which are: High pressure to the northeast of the country. This cold, dry air mass traverses the Caspian Sea and absorbs moisture and heat, making it unstable and producing significant precipitation within the state, especially in the fall (due to large temperature-water temperature differences). This rainfall intensity is greater than the rest of the state. This is due to the long travel path of air masses over the western part of the state.

– A modified polar air mass (mP) originating in the Atlantic enters the Eastern Mediterranean via the Black Sea and enters Iran from the northwest via Turkey.

– Continental Arctic air mass (CA) of Scandinavian origin, recovering water from the Black Sea after losing

water across Europe and entering the country's northern strip via Turkey.

#### b) Warm periods of the year:

– Modified tropical oceanic air mass (mT) originating from the Azores (Azores in the Atlantic Ocean), after crossing the Mediterranean Sea and southern Europe, enters the north of the country and occasionally Attacks Africa, Saudi Arabia, southern regions, central Iran and moves north. When this air front reaches the Caspian Sea, it absorbs water from that sea and causes rain on the southern coast. In addition, during the peak of hot days, the continental tropical air mass (CT) that forms in the very hot and dry central Iran also affects the northern part of the country as subtropical jets move north of the Caspian Sea.

#### Climate of Mazandaran Province:

1-According to the Hansen classification, the province is located in a temperate temperate zone.

2-Temoenatenus Index method says this state is extremely temperate and ultra-temperate (mitigation factor means to find the distance or proximity from an area to a temperate area)

3 –De Martounne Classification According to, the western region of Mazandaran is very humid, the central region of Mazandaran is humid, the eastern region of Mediterranean Mazandaran and the mountain region of Mazandaran are semi-humid.

4 - According to Dr. Karimi, the western and central regions have a humid climate with hot summers and slightly cold winters, the eastern semi-humid regions have warm summers and relatively cold winters, and the mountainous regions of Mazandaran have mild It has a humid climate with mild summers and very cold winters.

### III. RESULTS AND DISCUSSION

In this study, in order to investigate the phenomenon of climate change in Mazandaran province, the statistics of 4 important synoptic stations of the region have been used. The characteristics of the important synoptic stations investigated in this research are given in Table 1.

Table1: Characteristics of important synoptic stations used in this research

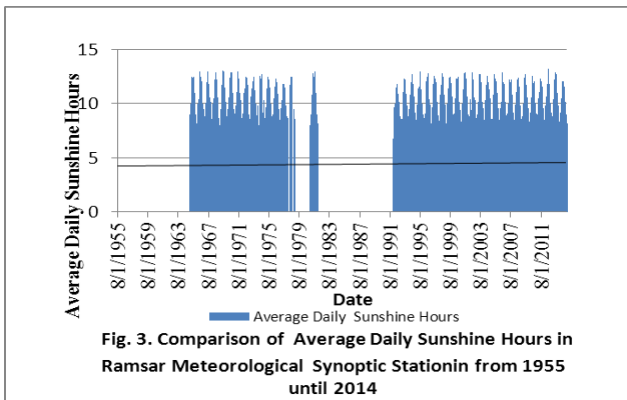
Row No	Station Name	Altitude (m)	Latitude	Longitude
1	Ramsar	-20	36° 54'	50° 40'
2	Nowshahr	-20	36° 39'	51° 30'
3	Babolsar	-21	36° 43'	52° 39'
4	Gharakhayl	14.7	36° 27'	52° 46'

Considering the importance of meteorological parameters of temperature and rainfall in climate change studies, the most important characteristics affecting these factors include average daily sunshine hours, daily rainfall,

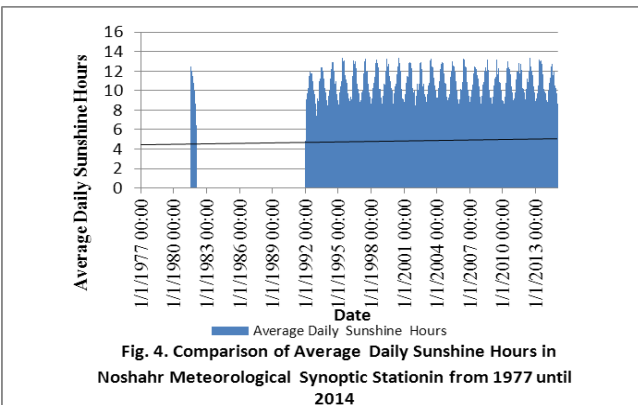
average daily temperature, average maximum daily temperature and average minimum daily temperature in selected stations in terms of trends and their changes during the available statistical time periods of the stations were investigated and researched in the following order.

**-Average daily sunshine hours**

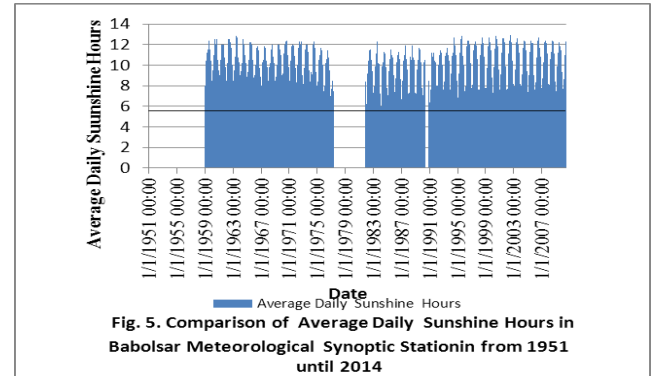
According to figure (3), the trend of changes in average daily sunshine hours in the Ramsar synoptic station during the year 1955 to the end of 2014 was investigated. From the examination of figure (3) and according to the trend curve of sunshine hours, it is clear that there are large fluctuations in the average. The daily sunshine hours during the study period can be seen fluctuations at this station. So that the number of sunny hours has fluctuated from about 8 to 12 hours and more during many years. Considering that the number of cloudy days in northern Iran is high and these fluctuations affect the air temperature and the amount of water vapor in the air, it can be investigated and studied.



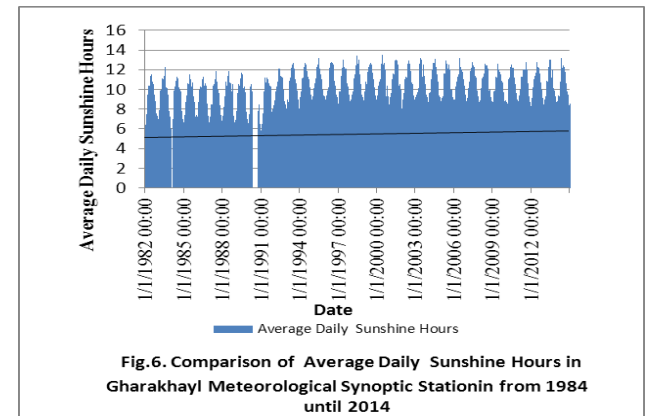
In Nowshahr synoptic station, which was the second investigated station in the west of the province, the trend of daily sunshine hours changes according to figure (4) has been investigated according to the available daily statistics from 1977 to the end of 2014. Of course, it should be noted that especially in the early years, the lack of daily statistics of this station was noteworthy, but the study of the changes in the sunshine hours of this station was also similar to the Ramsar station with a few changes, and it confirms the results affecting the climatic changes of this area.



According to figure (5), the statistics of daily sunshine hours of Babolsar station, which is one of the old synoptic stations of Mazandaran province, located in almost the central part of the province, were examined from 1955 to the end of 2014. As can be seen from figure (5) In this station, the changes in the hours of sunshine, which, like the other two stations, have fluctuated a lot, indicate the increase in temperature and heat in this area in recent years.

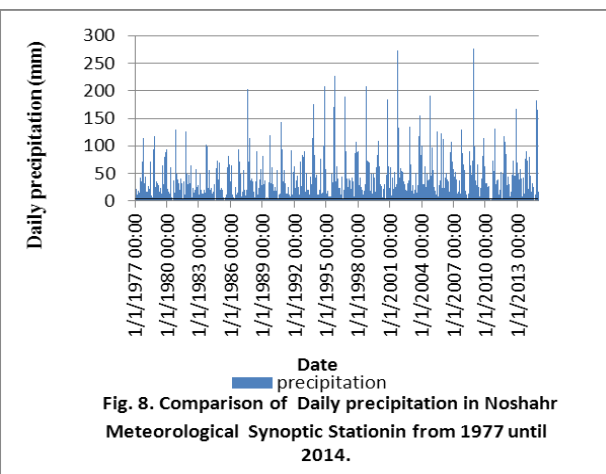
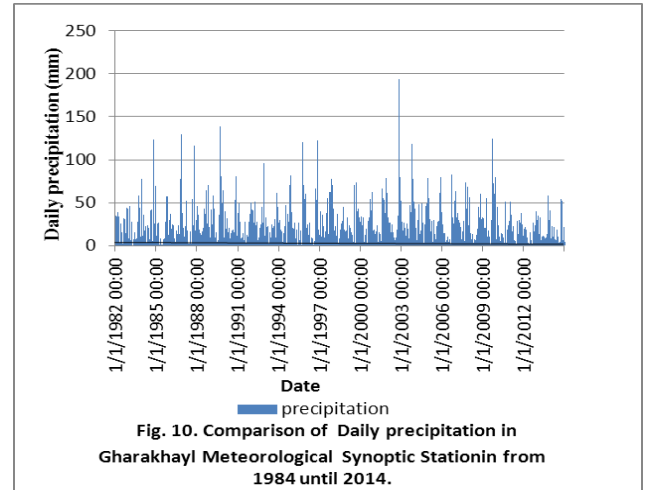
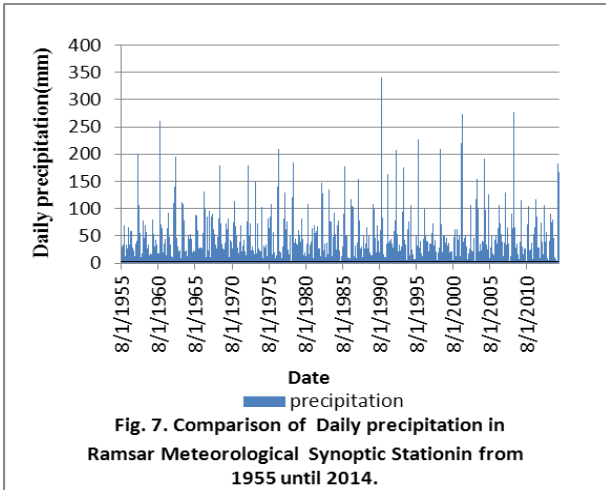


According to the available statistics. As it is clear from the figure (6), in a general conclusion, the trend of sunny hours of gharakhayl in Quaemshahr station, which is the eastern station investigated in this area, has seen many changes in the daily sunny hours of this station from 1984 to 2014. The general daily trend for many years is to increase the hours of sunshine and increase the temperature in this area, which certainly has a direct or indirect effect on other meteorological parameters.



**-Precipitation:**

The second studied parameter influencing the phenomenon of climate change in this area in the stations selected for this research was the daily rainfall statistics over many years. The results of this research about the Ramsar synoptic station according to Figure (7) have shown large fluctuations in the rainfall recorded at this station. So that as we get closer to the present time, these changes have witnessed more fluctuations, which confirms the impact of the climate change phenomenon in this area. The same results exist with a few changes in Nowshahr station (Figure 8).

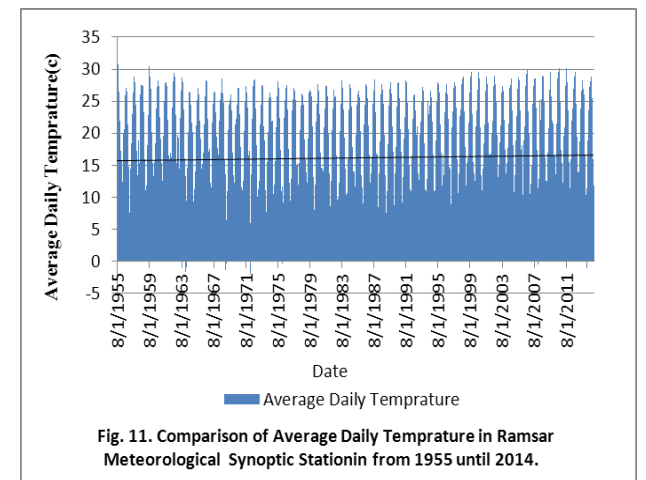
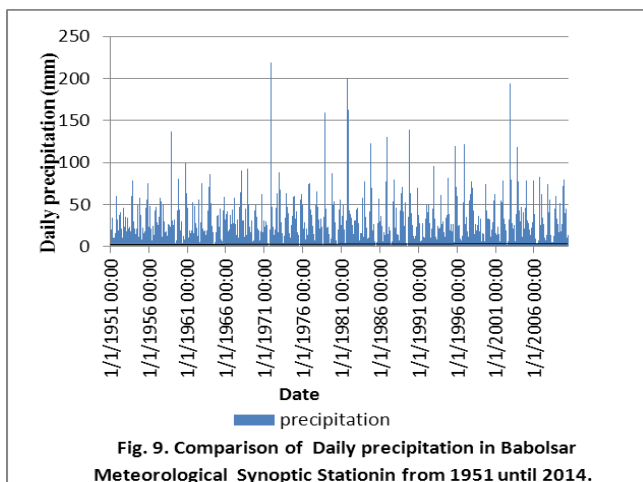


**-Average temperature, average maximum temperature and average minimum temperature:**

We can mention that temperature is the most important climatic parameter that affects other climatic parameters and their increase or decrease. The increase in temperature causes more evaporation of sea water and increase in humidity and in coastal areas due to the special situation of this region which is between the Caspian sea and the Alborz mountains are located in the north of Iran. This phenomenon can cause hotter summers, as well as an increase in air humidity and heavy rainfall in this region, especially in the months of autumn, including October, November and December, which in terms of impact It can be studied and investigated on the creation of floods in these areas.

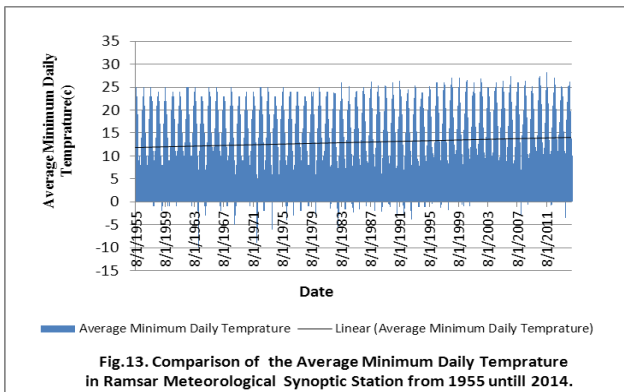
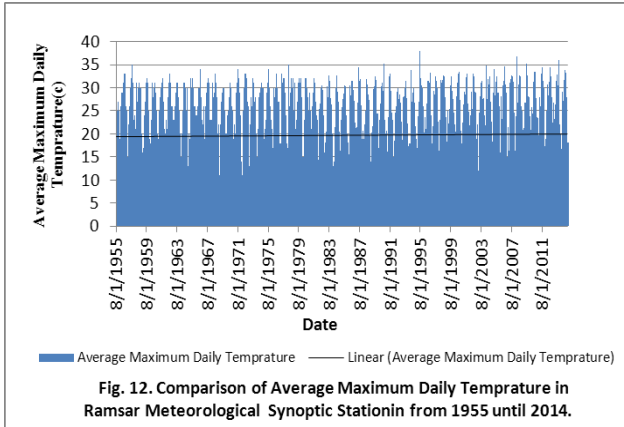
According to figure (9), from the analysis of the daily rainfall statistics of Babolsar station and also the trend curve of rainfall changes during many years from 1951 to 2014, it can be concluded that there have been many fluctuations in this region in terms of rainfall. In gharakhayl,Quaemshahr station, whose available rainfall statistics have been analyzed from 1984 to 2014, we can see a lower amount of rainfall compared to the previous stations, and this trend has had a significant peak on some days of the many years under investigation. (figure 10).

The temperature fluctuations of the Ramsar station, which have been examined daily from 1955 to 2014 (Figure 11), have shown large temperature changes in the area of this synoptic station. It is worth mentioning that the closer we get to the present time, the better we see temperature changes and temperature increases.

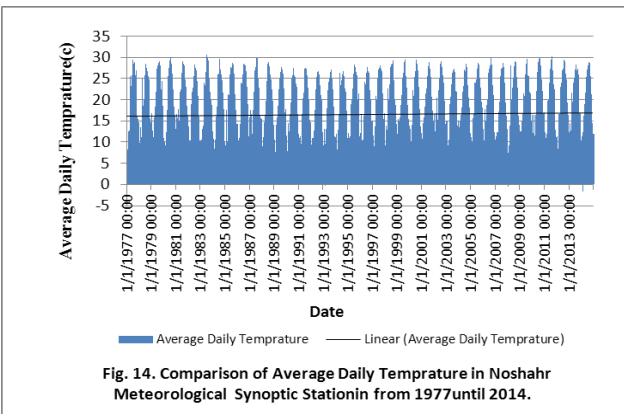


According to figure (12), the average daily maximum temperature of this station during the many years under

investigation reaches about 35 degrees Celsius, and the study of the average daily minimum temperatures during the many years of this station also shows large fluctuations in the minimum temperature. Some days have been for many years .figure (13)

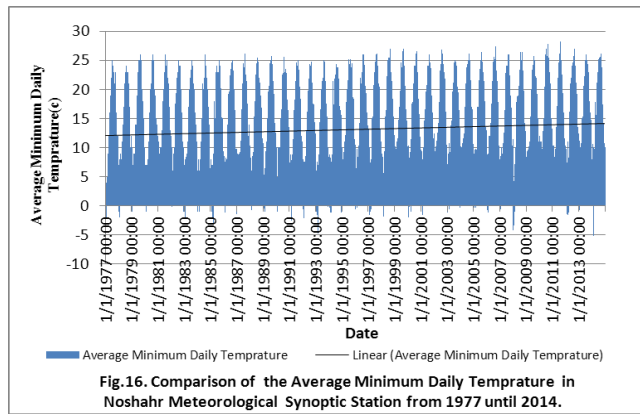
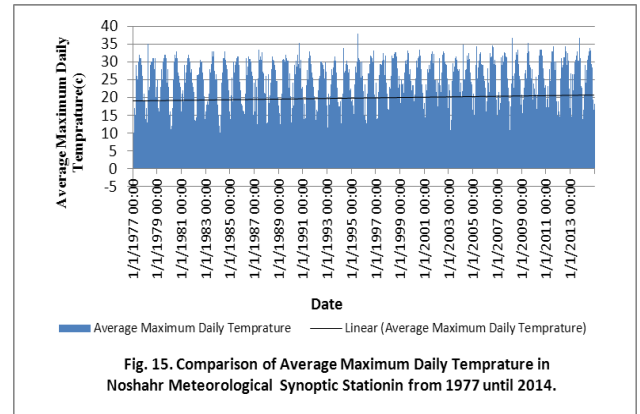


According to figure (14), at Nowshahr station, which is the second synoptic station investigated in the west of Mazandaran province, the trend of average temperature fluctuations in the period of 1977 to the end of 2014 has been investigated on a daily basis.

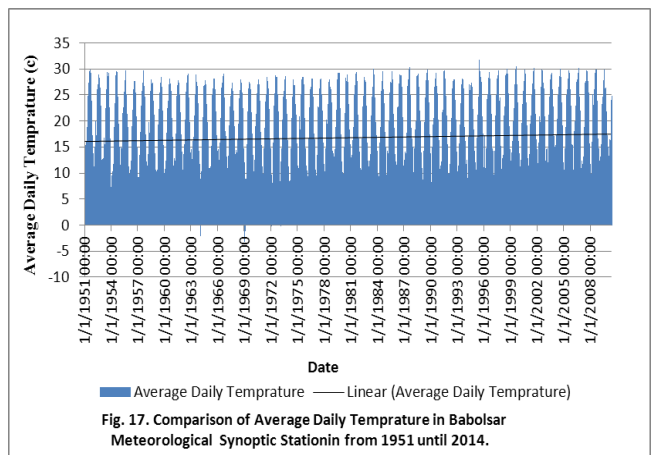


From the examination of this figure, it is clear that the fluctuations of the average temperature of this area have been increasing according to the trend curve, and the examination of the average maximum and minimum temperature also confirms the large changes of these two

parameters in this area and confirms the impact of the climate change phenomenon in this area.(Figures 15 and 16).



In Babolsar station, from the examination of figure (17) of the average temperature trend from 1951 to 2014 on a daily basis, it also confirms the general increase of the mentioned trend in this station and the proof of the warming of the mentioned period, and about the increase of the average maximum and minimum temperature (figures 18 and 19) also shows the curve of increasing temperature changes in the desired station. In such a way that the maximum daily temperatures of the climate change in the area are more and the minimum daily temperatures are also increasing, which is evident in the phenomenon of climate change in the area.



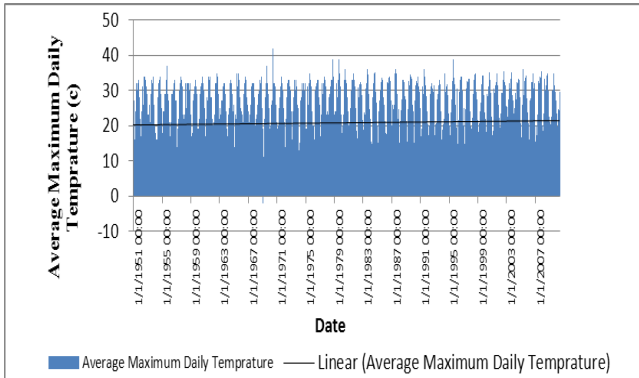


Fig. 18. Comparison of Average Maximum Daily Temperature in Noshahr Meteorological Synoptic Stationin from 1951 until 2014.

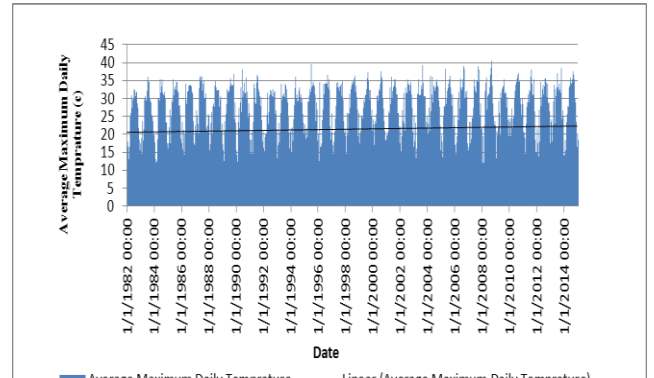


Fig. 21. Comparison of Average Maximum Daily Temperature in Gharakhayl Meteorological Synoptic Stationin from 1984 until 2014.

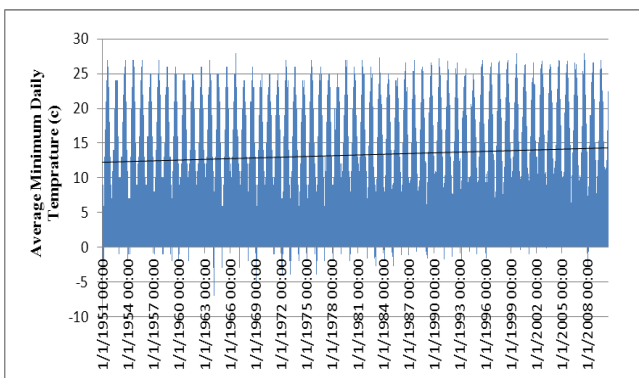


Fig.19. Comparison of the Average Minimum Daily Temperature in Babolsar Meteorological Synoptic Station from 1951 until 2014.

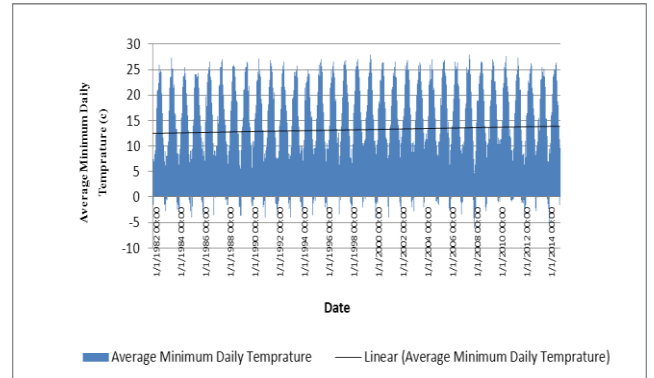


Fig.22. Comparison of the Average Minimum Daily Temperature in Gharakhayl Meteorological Synoptic Station from 1984 until 2014.

The increase in the average daily temperature from 1984 to the end of 2014 is also evident in gharakhayl of Quaemshahr station(figures 20).. This increase proves the upward trend of the mentioned trend curve until the recent period. (figures 21 and 22)

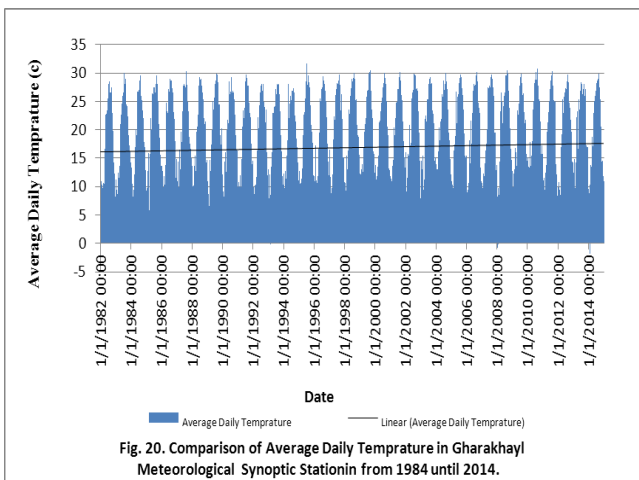


Fig. 20. Comparison of Average Daily Temperature in Gharakhayl Meteorological Synoptic Stationin from 1984 until 2014.

#### IV. CONCLUSION AND FUTURE SCOPE

The extensive effects of the climate change phenomenon can be seen according to the statistics of the synoptic stations investigated in the study area on the influential climatic factors of the region. The location of Mazandaran province in the north of Iran and the humid climatic conditions of this area, which is located between the Caspian Sea and the Alborz Mountains. The results of this study show the impact of the climate change phenomenon in this province. According to the number of statistical years in the stations in the region and the selection of these stations from several points of this region in the west and center of this area, it can be concluded that the future climate change trend of this area has an important effect on the weather conditions of region.

Considering that this province is one of the poles of rice production in the country, and on the other hand, in terms of other agricultural products and various citrus fruits that are grown in this area, we will see many changes in these products in the future, so that if careful planning If it is not done to deal with the harm effects of climate change in the study area and other areas, it can have destructive effects on the agriculture of the area. According to the results of this research, the importance of issues related to water resources management and watershed management strategy is more clear in this province.

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