

The Synoptic Analysis of Snow in Guilan Plain

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ABSTRACT

Snow fall is a common and usual phenomenon in mountains, and the inhabitants of these regions are ready enough to face such phenomenon. But a heavy snowfall in low areas and plain is somehow inestimable and unpredictable. If this heavy snowfall continues during a few days, it will have negative effects on all the daily routines of people.

The place where is studied is the plain of Guilan. The data that is used contains fallings from the sky, and the characteristics of it (the amount of snow and the snowy days), which is gathered from 4 synoptic stations in this plain.

The methodology to the recognition of the systems lead to the snowfall is the analysis of the synoptic maps in a 500HP land at the time of 00.

The results of this research show that the synoptic sample lead to the snowfall is affected by the cold weather of the pole and the dominant of the polar low pressure which is entered to this region by the western winds, and causes a very cold weather in a wavy arrangement. The trough axis of this system is usually north to south, and lasts more than 3 days in the region. The cause of humidity is mostly from Caspian Sea and then the Mediterranean and Black Sea.

KEYWORDS: Caspian Sea, Guilan plain, Snow, Falling from the Sky, Synoptic pattern.

1. INTRODUCTION

Snow is the solid from of the falling from the sky, and it has a deep effect on the balance of the radiation, this phenomenon and the way of its occurrence is sometimes unpredictable, and consequently puts a lot of negative effects.

But is this occurrence under the influence of a certain order? And, is it predictable?

Based on the previous question, in this research paper, snowfall in Guilan plain-north part of Iran is studied. The center of the snowfall are Rasht and Anzali where are damaged mostly on this crisis.

The most population of the province is gathered in these cities, because of the appropriate natural conditions, and enough water. The general altitude of these plain isles than the free waters, and the widest Coastal area is located here. The transmission of the air and moisture from Caspian Sea to the central plateau of Iran is the most important natural characteristic of Sefidrood valley. The data from the aero logical stations show that, Guilan province faces such a vive phenomenon more than other provinces in Iran.

The analysis of this phenomenon, and the management of it will reduce the damages Caused by the frequency and intensity of is both discussible and valuable.

But, the question which arises is that why such events occur repeatedly, and the rate and the amount of damages puss an ascending procedure?

It seems that, the authorities don't pay much attention to this point in the establishing planning and activities of the province. So, all considered viewpoints and results of the researches are valuable which lead to the various solutions, and then the managers.

Can find the appropriate approaches to reduce the damages caused by this phenomenon.

In this research, it is attempted to analyze the snowfall, and then the following question is asked, and finally, an appropriate answer through the process is found. It is the goal.

Do the heavy and destructive snowfalls have any relation with the certain (specific) synoptic pattern?

The present literature about the subject of this research is gathered in a form of thesis's, research reports, and applicable plans, and most of them are related to the cold, mountainous areas. The recognition and the introducing of the great scale climate models which are effective on the variety, of the snow fall in the east of united states, done by Jennifer Morin, 2008 is one of these researches, in which, the variety of snowfall, and the relation of it with the general climate of the east of united state

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is studied. The variables of the research Contain the snowfall (TSF), and the number of the days (NSD) which are gathered from 124 stations, and then are analyzed with the help of the software's of computers.

Table 1. The Amount of Damages Caused by Natural Hazards in Guilan Province (2004-2008)

Year	Kind of Event	(Billion Rial) The Certain Hazards					Total
		Agriculture- Fisheries	Residential & Business	Basis- Administrative Foundations	Industries	Tools & Devices	
2004	Flood, Storm, Foehn	27	29	102	-	-	158
	Snow	362	1327	1207	1093	4	3993
2005	Flood, Storm, Foehn	91	19	45	-	-	155
2006	Flood, Storm, Foehn	17	9	30	-	-	56
2007	Flood, Storm, Foehn	4	1	48	-	-	53
	Snow, Permafrost	1547	231	824	26	12	2640
2008	Flood, Storm, Foehn	65	131	301	-	-	497
	Drought	1130		1000	-	-	2130
Total		3243	1747	3557	1119	16	9682

Referenc: *The organization of management and planning of the Committee of Crisis.*

The outstanding case to both variables of TSF and NSD is related to the fluctuation pattern of North Atlantic (NAO).

The second pattern to the variety of TSF is related to the Pacific Ocean and North of American pattern (PNA).

Amininia and his colleagues (2010) have done a research under the title of, the analysis of the fluctuations of the heavy snow falls on the northwest of Iran. He has used the daily statistics of the temperature and the snowfall of the 10 synoptic stations, and has found that, the snowfall in all stations faced a great fluctuation and has had a reductive process, during the period of statistics.

Adeli (2005), has studied ' the climatology of the snowfall in northwest of Iran', and the climatology organization of Iran has published airport under the title of ' the analysis of the snowfall', in which the prediction of the snowfall is proposed.

Annette Semadeni Davies (2000), the professor of Lund University in Sweden, has studied 'the mutual effects of the urban weather and show. The results of this research show that, albebd a very great effect on the balance of the urban radiation, because of the pollutions; snow- melting is another effect on the urban ecology.

The province office of Guilan has published report under the title of ' white crisis', a year after the snowfall of 2004, in 2005. This report contains the dimension, the losses and the activities that are done in that certain crisis. The analysis of the documents and references show that the probability of the prediction of such phenomenon is weak, and that's why the necessary efforts (measures) to stand against such phenomenon is not seen in the urban structures, not structural nor on the surfaces (appearances).

The analysis of the engineering directions, and regulations, show that there isn't much attention to this phenomenon, and unfortunately the engineering standards which stand against such heavy snowfalls, aren't enough.

This is the main reason of the damages and losses, and also the greatest cause of the surprise of the authorities.

2. MATERIALS AND METHODS

2.1. Material

The data that is used in this research contain the statistical data which is gathered from 4 synoptic stations where are located in the scope of the research, and the synoptic plans of the different levels of the atmosphere and also gathered from the site of the global climatology organization (www.cdc.noaa.gov/cdc/data/ncp.reanalysis/htm1). The raw data and the recorded data in 4 stations of Anzali, Rasht (airport), Astara and Lahijan are as follows in fig1, table 2.

Table 2. The characteristic of aero logical Stations which are studied

Station	Year of Pioneering	Elevation	Latitude	Longitude
Anzali	1328	-23.6	37° 28'	49° 27'
Rasht	1334	-8.6	37° 19'	49° 37'
Lahijan	1381	34.2	37° 11'	50° 00'
Astara	1364	-21.1	37° 21'	48° 51'

Ref: Iranian Meteorological organization

The data contain precipitation, snow, snowy days, temperature (Means of Max, Min, Monthly, Annual and Lowest), are used on the research proportionately.

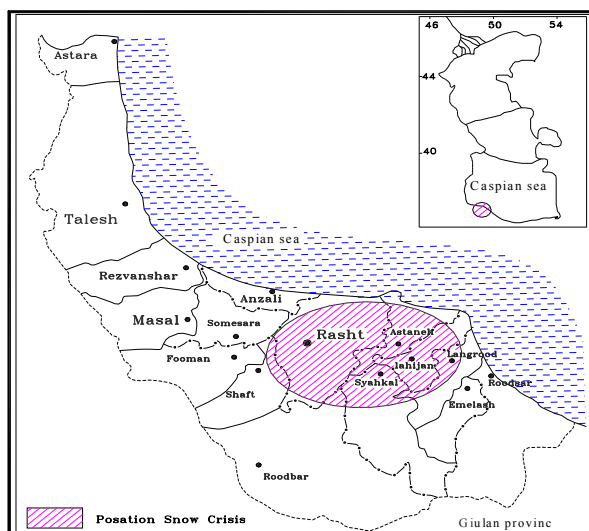


Fig 1. Position of damaged region at snow crisis Feb. 2004. Iran- Rasht

2-2. The Method of The Analysis of Data

To the analysis of the synoptic systems which lead to the snowfall, the snowy days in the studied stations in the present statistical period (1951-2005), are gathered from the climatology organization, and then the related data is derived. Two indicators of the snow samples are related to the years of 2005 and 2007 when are chosen. The used data on the synoptic analysis and choosing model of the snow is not only the statistical studies, but also the synoptic plants of the surface of the ground, and it is 500HP.

The method of study is the analysis and the description of the synoptic plans to the derivation of the synoptic models. In this level, the plants are examined, and the synoptic components on the ground to 500 HP are measured. From the establishment of those systems lead to snowfall.

The related system are recognized after the study and analysis of the synoptic plants, the patterns lead to the heavy snowfall, and the recognition of the synoptic patterns of the ground and the middle levels of the atmosphere.

3. Research Findings

The studied area in the central plain of Gilan contain Emamzadeh Hashem, Kiashahr and Hassan rood, stretched across Sefidrood valley. This is extensive area against the eastern, and northwestern-plains of the province and the vote of the falls of it are nearly 1600mm on the seaside and it is reduced near the land. From a near distance of Anzali to the south of Rasht, the rate of the fall is reduced to 300mm, and the curve of 1300mm is passed from the south of Rasht. This reductive process continues to the suburbs of Sangar, and it is around 1200mm. on the south of Sanger, there is an aerographic ascent ion because of the encounter of the air-mass to the western Alborz Mountains and southern Talesh. Typically, the rate of fall is increased to 100mm and reaches 1400mm (khoshraftar, 2005).

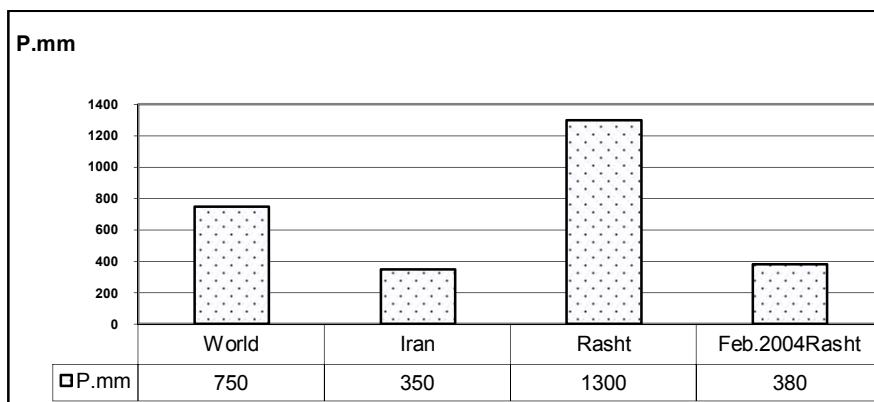


Fig2. Comparing the height of snow in Rasht (Feb. 2004) with the annual average of the world, Iran, and Rasht

Sefidrood valley plays a very important role on the south of Caspian Sea, because of the Trans mission of the vapor to Guilan plain. If the rainy systems pass across the valley above Caspian Sea, the heavy falls are happened. If this system arrived at the area in winter, the falls are in a form of snow and because of much vapor, the movement will have heavy weight.

3.1. The Record of the Snowfall in Guilan

The analysis of the statistical data and the documents show that, the heavy snowfall in Guilan province is an exception completely, but it is important because it sometimes causes a heavy crisis for example on Feb. 1959, cover of snow with the thickness of 1 meter lasted a few days (Bazen, 1979, p. 76).

In winter 1971, Guilan plain faced a heavy snowfall with the thickness of 1.5 meters, it lasted 6 days, and the water which was gathered after snow melting was nearly 268 mm. The last heavy snow falls are recorded on 7th to 10th of Feb. 2004, and there years later on Jan 2007.

The Thickness of snow in Sefidrood Delta was 1 to 2 meter, but it was reduced gradually from the top of Delta to the shore, and lasted 10 days. It was around 2 meters in the top of Delta, 105 meter across the road of Rasht - Astaneh, and 15 centimeter in Kiashahr port. The water which is gathered of the snow-melting is equal to 380 mm. rain falls.

The altitude of the global average of the water caused by snow-melting is compared with Iran and Rasht in figure 2, and the altitude of the snow on Feb. 2004, was more than the annual amount in Iran, and it is around half of annual fall in the world, and more than a quarter of annual fall in Rasht station.

3.2. The Analysis of Synoptic of the Snow.

The analysis of the synoptic systems which lead to the heavy snow fall on the area of the research is related to this dates: 8th to 11th the Feb. 2004 and 5th to 13th Jan. 2007.

3.2.1. The Snow Fall in 2004

The heavy snow fall on 7th to 10th Feb. 2004, occur in Rasht and the surrounding area during 4 days and the altitude of 106 meter.

The snowfall was weak during the first days, but it wasn't predictable on the final days. The altitude of snow was 26 centimeter on the first day, but it reached 160 centimeter on the fourth day.

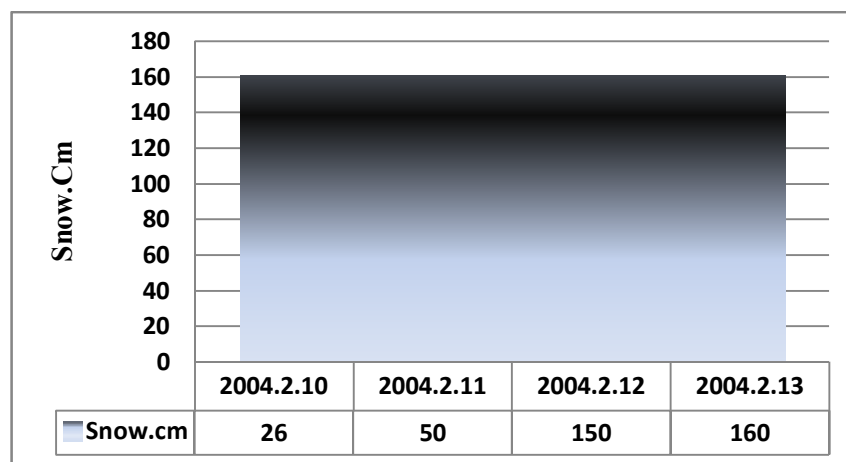


Fig 3. Snow height, Feb. 2004 in Rasht station according to days

The synoptic characteristics of the snow are related to the plans of the surface of the ground and it is 500 HP.

It is analyzed on Feb. 7th to 11th. 2004, and the patterns lead to heavy snow falls are examined as followings.

The Surface of The Ground

The analysis of these plants (figure 4) on Feb. 7th the inception of the snow-show that the low pressure influence Island is to the North of Europe.

The axis of this system is stretched to the east of Black sea, and the heavy cold wither has sent the high latitudes to the north of Black sea. In the south of this high pressure beside the tropical, and above the ocean is stretched across the axis of 40° to center of Mediterranean Sea. Two minor (secondly) high pressure axis with the central pressure 1027.5 HP are derived from this system and are established on the west of Caspian Sea and south of Black sea. A rotator is located on the east of Mediterranean Sea and North of Red Sea.

The situation of the central core of this system is seen by the pressure of 1012.5 on the eastern meridian 32' and the North axis 31' on the south east of Mediterranean Sea.

It seems that the main part of Iran, and especially the area of this research is under the influence of the indexes caused by the high pressure of Azor. The 105 pressure of Island put more heavy influence on the southern areas on Feb.8th, and the two high- pressure centers on the south of Black sea are weaken in comparison to the previous day, but as an avoiding system, prevents the low-pressure of Europe. The Northern parts of Caspian Sea are under the influence of the low-pressure of Europe on Feb.9th, the deep influence of the polar low pressure of the down latitudes causes the withdrawal of all systems on Iran and especially the northern half of the country.

The stretching of the trough axis of this system on Caspian Sea causes the transmission of the cold and humid weather to the province, and especially Sefidrood valley.

The analysis of the plan of the surface of the ground on Feb.10th, and the end of snow fall show the establishment of this system on the area of research.

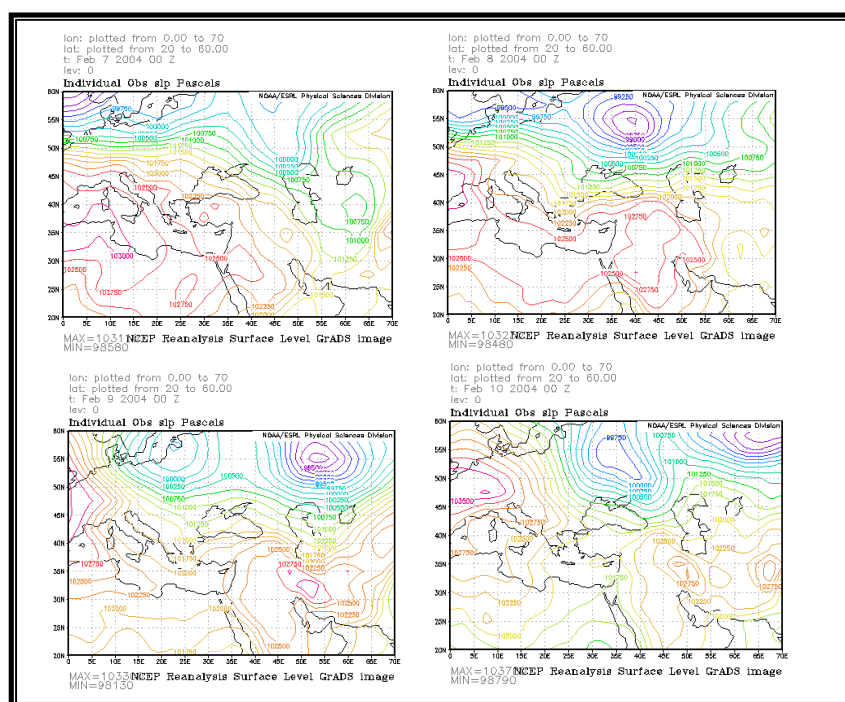


Fig4. The Synoptic Pattern of the pressure of sea level on 7th to 10th Feb.2004, time: 00

The Level of 500 HP

The western winds cause a deep down (descend) on Mediterranean Sea on the level of 500 HP.

This system is stretched to the east of Mediterranean Sea with a closed cell, and as an avoiding system, prevents the western winds come to the area of the research and north of the country from two different paths. The axis of this down (descend) begins from the east of Mediterranean Sea in the orbit 25', and western Mediterranean 45' to the Northern latitude 50'. The depth of this down (descend) is about 5600 meters. On Feb .8th, the polar low pressure puts more depth on the down (descending) latitudes, and trough axis 5', has had a meridian movement toward the east. And on the first day of the snowfall, the trough axis is stretched on Caspian Sea north to south, across meridian 50' to the southern orbit 20'. It seems, the only dominated system on this area is the influence of the deep western winds, in which the immigrant silcones arrive the area. And cause the heavy snowfall. The analysis of the plans of snowy days shows the domination of this system on this level.

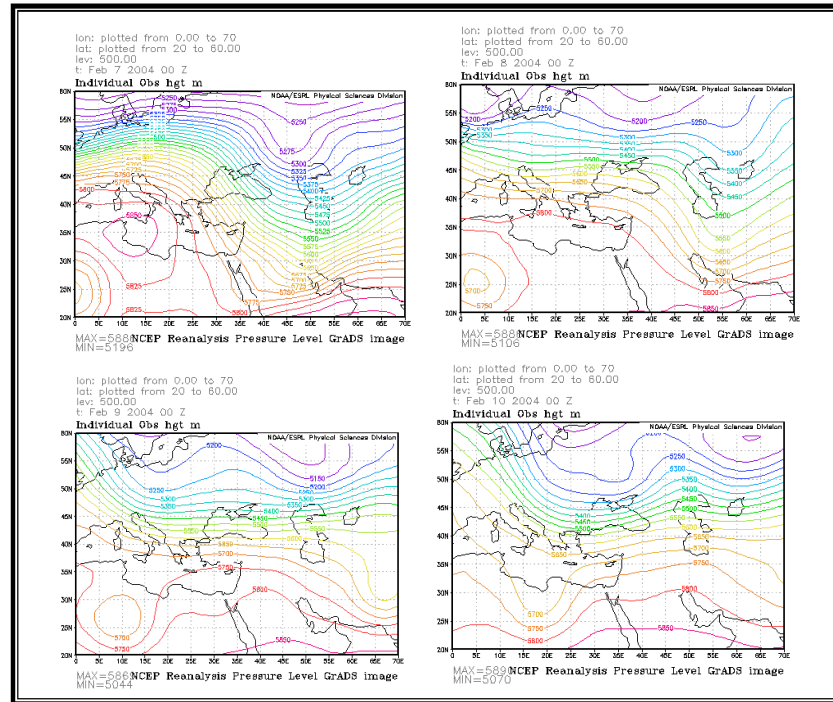


Fig5. The arrangement Pattern of the 500HP surface on 7th to 10th Feb.2004, time: 00

3.3.2. The Snowfall in 2007

Another sample to the analysis of the synoptic heavy snow, relates to the snowfall on Jan. in 2007 .in comparison with the snow in 2004, this snowfall covered an immense area, especially in central Guilan plain with in10 days. This system domination north of the Country within 10days in a form of two successive waves, and it causes a heavy snow fall especially in Anzali, and then Rasht. The synoptic plans of the general atmospheric movements show that, there is a family high-pressure system on the middle belt of the atmosphere, and the influence of low pressure of Sudan to Azerbaijan, and its accompaniment to the active low altitude of the middle levels of the atmosphere, is also existed. The absorption of enough humidity of Mediterranean Sea and Caspian Sea and then the improvement of it, and finally pass through the southern coasts of Caspian Sea. Cause both rain and snow fall on the great part of Europe, Iran, and the southern coasts of Caspian Sea.

According to the synoptic plans of the surface of the ground, and the middle level, it seems that the cold high pressure system pass on the middle round (turn belt), and this is the cause of the permanent cold weather on the Northern half of the country.

3-3-2-1. The Analysis Of The Application of Snow on Jan. 4th to 7th in 2007.

(First wave):

On 15th in 1386, a cold polar high-pressure system with the center of 1044HP Established on North of Caspian sea, and speeded the cold waves of it with the isobar of 1028 HP on the area of the Northern half of the country, The climate in different regions of the province decreased about 6' to 9'C. And Guilan province faced both the snow fall and wind blowing this wave accompanied with low-altitude and humid waves. And based on the topography of the region and the absorption of enough humidity from Caspian Sea, the snowfall was intense on the central part of the province. It should be noted that the falls on the central parts of the province are usually more than the other parts of the province. This system is active in the region about 60 hours, and the altitude of the snow is 30 cm to 100cm in the central regions and 150cm on the mountains.

The Surface of the Ground:

The analysis of the plans of this level (Fig6) Jan. 5th show that, a preventing system is established on Caspian Sea on the east of Mediterranean Sea and the low pressure of Island is moved to aural east, and the trough axis of this system is established on Caspian Sea across North West to southeast. It seems that, the cold weather from the west and the movement of it on Caspian Sea is the Cause of the transmission of cold and humid weather to the province, especially Sefidrood valley.

On Jan 6th. (Day 16th.)the system of the previous day dominates on the region completely, and stretches from Mediterranean sea to south of Caspian sea with the central pressure of 1015 H.P. as a family low pressure system .and it is the cause of the instability of cold weather and the permanency of

in the limited region. In this day, the low pressure of Island is on the North of above system, and the high pressure tropical is on the west and southwest of this system. Sudan low pressure is influenced to the southern parts of Iran. On Jan.7th. the low pressure on Caspian sea is transported to the east of it and North of Baikal lake, and a high-pressure system with the central pressure 1030H.P. and the two in dependant centers are seen among Caspian, Black and Mediterranean sea, the system of the previous day is established on the region on Jan 8th., but the low pressure on bay cal lake is improved and it is stretched toward west. The polar low pressure system is established on Caspian and Mediterranean Sea.

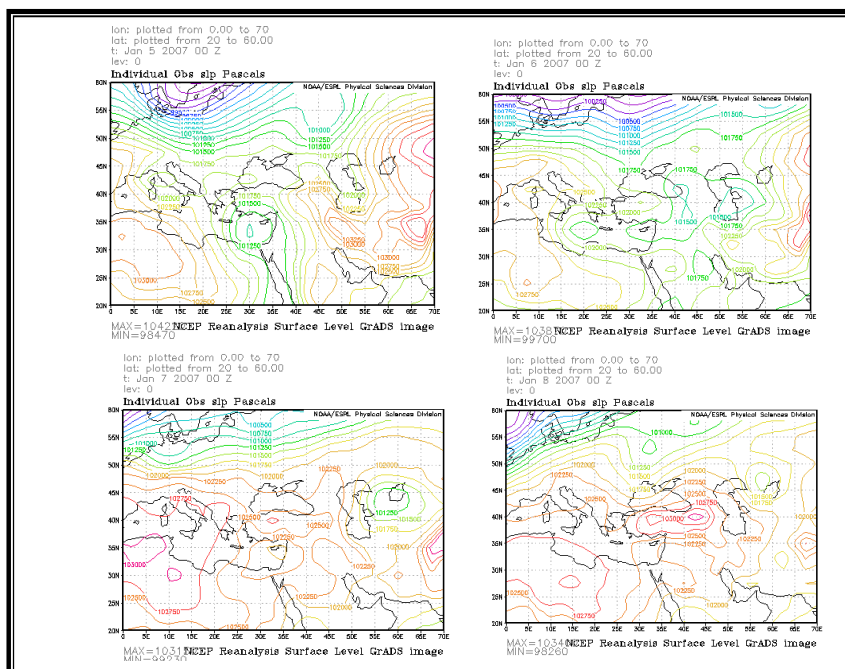


Fig6. The Synoptic Pattern of the pressure of sea level on 5th to 8th Jan.2007, time: 00 (First wave Snowfall)

The Surface of 500 HP:

The analysis of the plans of the surface of 500HP shows that on Jan.5th. This system is moved a little and gives the central atmosphere of Iran on Jan 6th. The center of the cell is moved toward the east and the altitude lines are compressed on the southern Casts of Caspian Sea. On Jan.7th. The low altitude system is established on Caspian Sea completely and the cold weather with the humidity is the Causes of heavy snow fall on the shores. This situation continues the next day (Fig7).

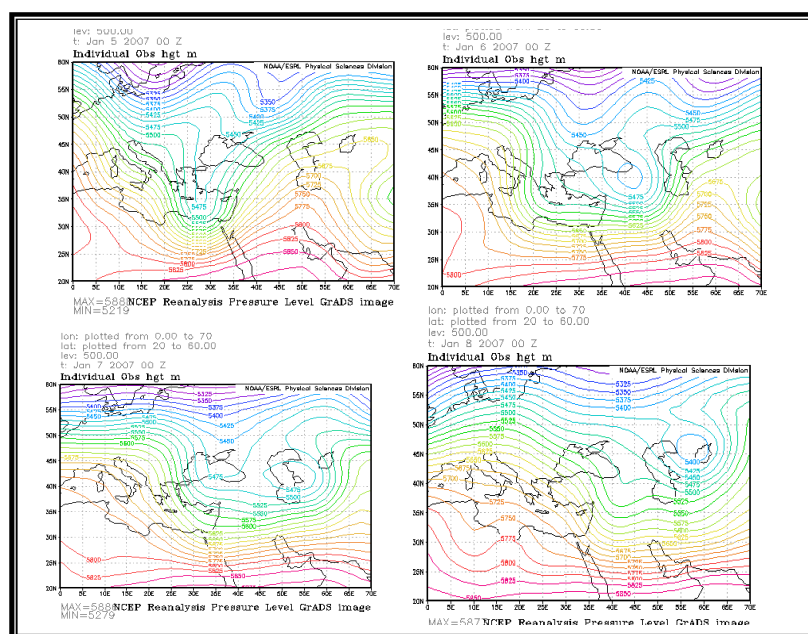


Fig7. The arrangement Pattern of the 500HP surface on 5th to 8th Jan.2007, time: 00 (First wave Snowfall)

3.3.2.2. The analysis of the application of snow on Jan 9th to 13th. In 2007

(second wave); on day 21th in 1386, the co-pressure of 1032HP of the cold polar are mass with the center of 1050H.P. on the southern coasts of Caspian sea, and accompaniment of it with the low-altitude of the middle levels of snowfall is begun on the different regions of the province and is continued to the 36 hours. The entrance of this system influenced whole the province, and the climate in some stations especially mountains is decreased to -16°(Fig8).

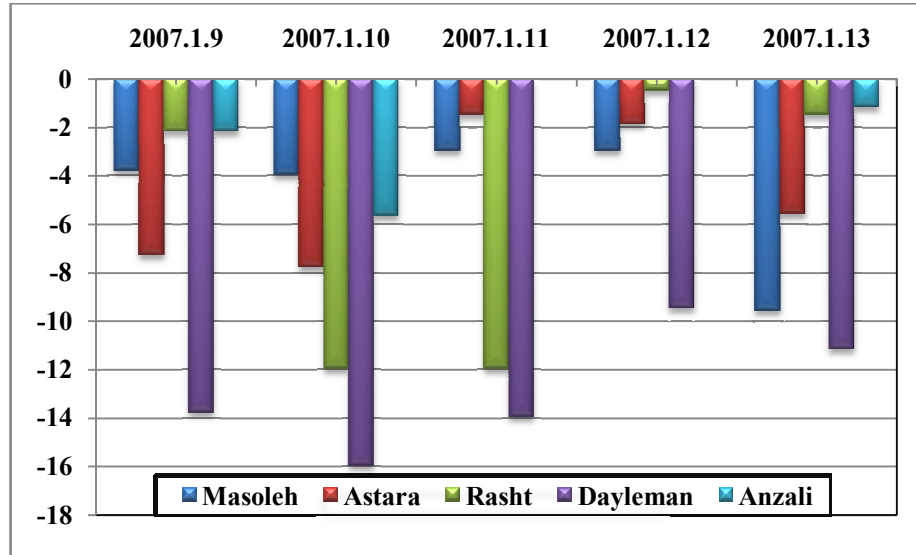


Fig8. The Diagram of the minimum temperature (Second Wave)

Whit the slow movement of this system to the east, the falls are stopped temporarily in some regions on west and east, but it is decreased in central regions of the province.

The cold solar air mass is returned again, and it high pressure is the cause of the falls in the next 24 hours. This fall is scattered on most of east and west areas, but on the central parts of the province (Rasht & Anzali) it is stronger (Fig 9&10).

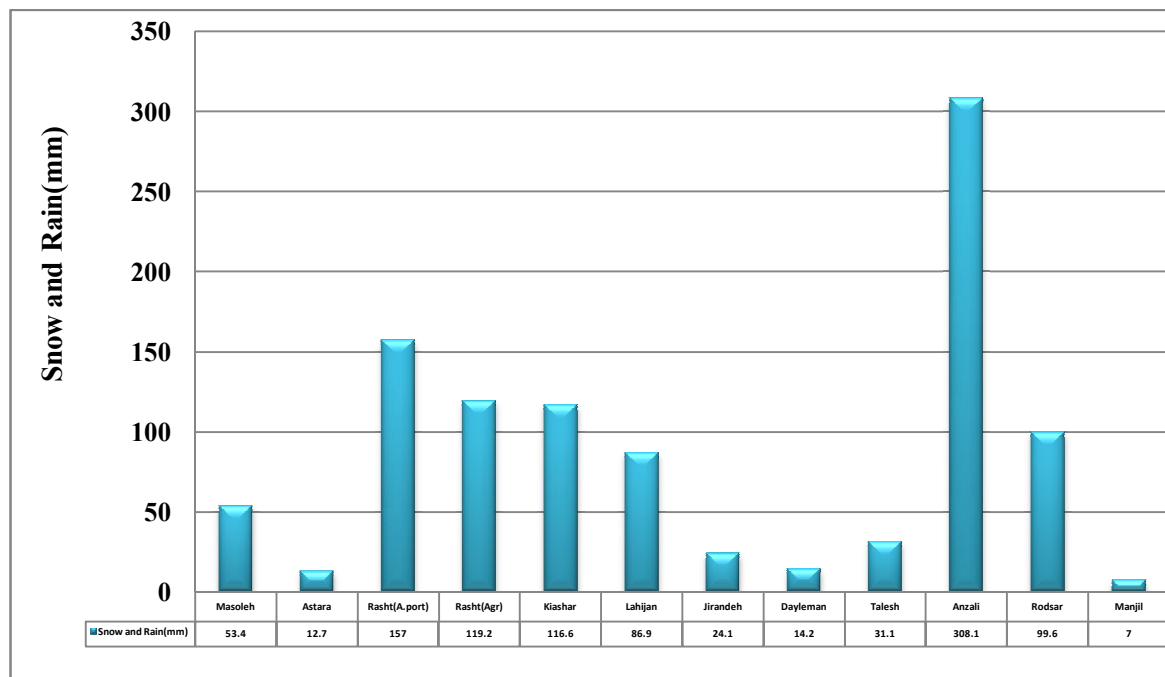


Fig9. The total water fall of Snow and Rain

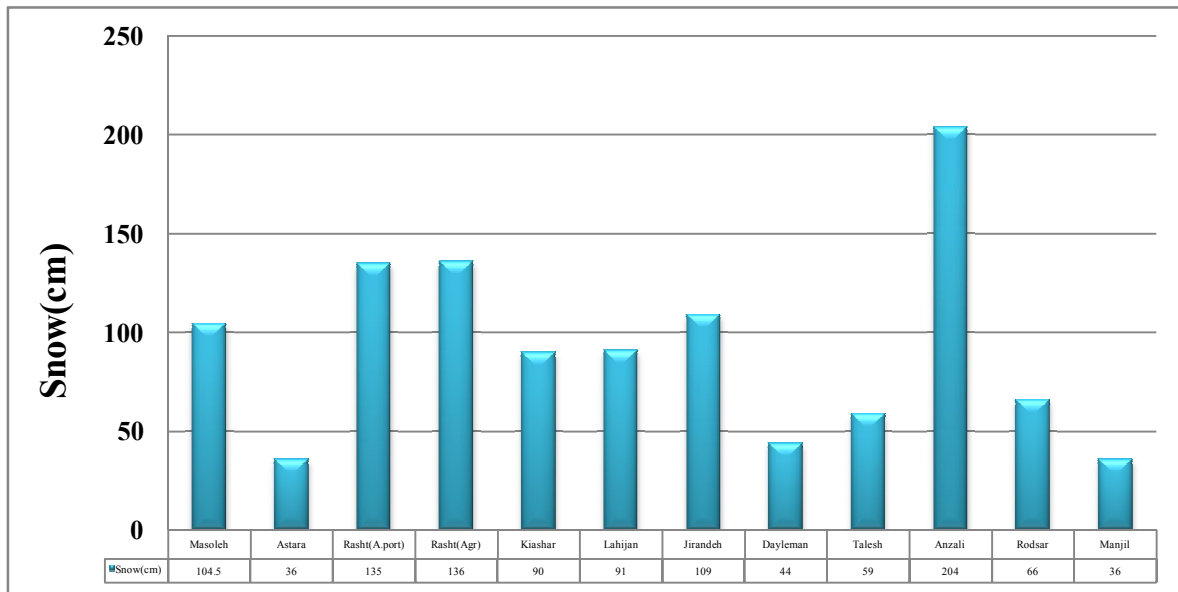


Fig10. The average altitude of Snow in Guilan province

The Surface of the Ground:

The low pressure of Island and the secondary systems within it, the path of movement, and the cold weather are the Cause of the heavy snowfall of the previous day.

On Jan.9th .This system was gone out of the region and the analysis of the Isobar Lines show that the waves Caused by the low pressure of Island with 1025 H.P is dominated on the Northern half of Caspian sea a day later, the waves Caused by the polar low pressure are stretched toward the southern Coasts of Caspian sea. On Jan.10th. A family high pressure is dominated through Mediterranean Sea to the west of Caspian Sea from west to east, and Caspian Sea is under the influence of low pressure of Island which the axis of its trough is stretched from North to south.

The high pressure on Mediteramain sea is moved to the east and the balance line of 1032H.P of it acts as a preventing system in North, and it Causes the variation of the polar low pressure on south of Sudan low pressure.

On Jan 12th .the polar low pressure has more influence toward the south, and this deep influence causes the transmission of move humidity and continuous heavy snow fall.

On 13th day. The cold weather of polar low pressure on Guilan plain Causes a heavy snow fall on most of the regions.

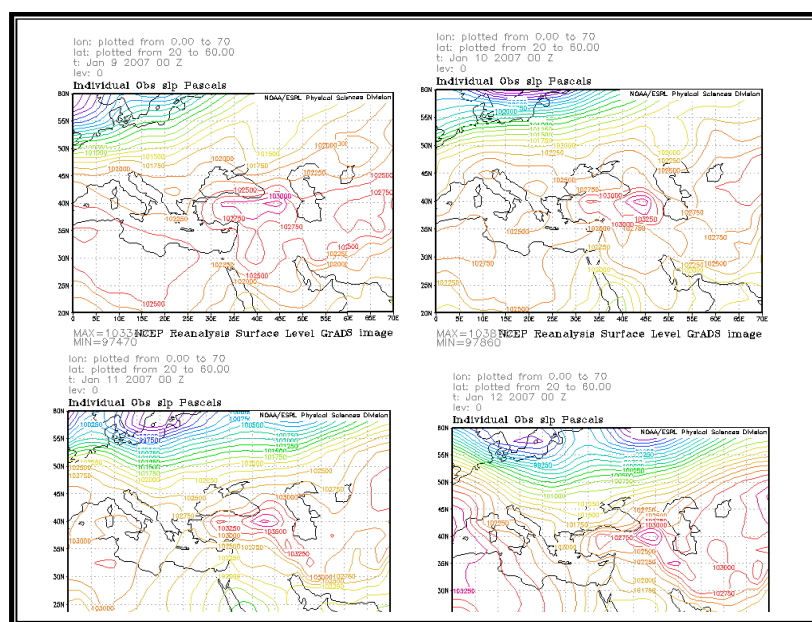


Fig11. The Synoptic Pattern of the pressure of sea level on 9th to 12th Jan.2007, time: 00(second wave snowfall)

The Surface of 500 HP:

The analysis of the middle levels of the atmosphere during 5 days on the second wave show that, a polar low pressure is dominated completely.

The main center of this system is located on North axis 50', and more. But the waves Caused by the system of axis 20° are stretched to the North. On Jan. 10th, a low altitude is formed on the center of Mediterranean Sea, and Trough axis of it, is across the North-east to south-west. On Jan. 11th, Trough axis is moved to the east of Mediterranean Sea, and a secondary center is established on the North of Bycal Lake. This Trough axis causes the transmission of the humidity on Caspian Sea. The result (outcome) of this establishment is that a heavy snow fall is seen. On Jan. 12th, and 13th. The above system weak, and stretches to the higher latitudes, but the studied area is under the influence of this system completely.

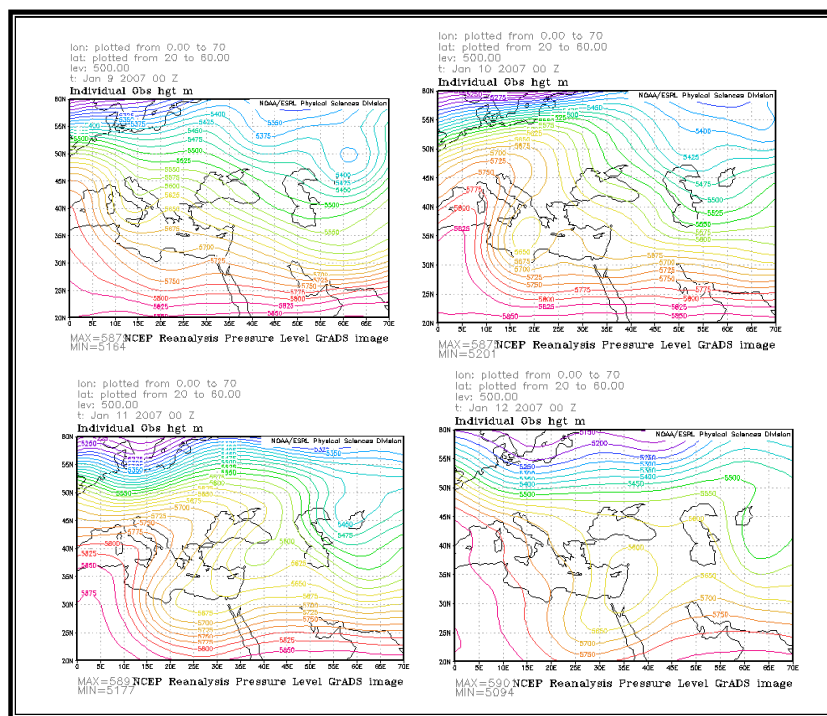


Fig12. The arrangement Pattern of the 500HP surface on 9th to 12th Jan.2007, time: 00(second wave snowfall)

4. DISCUSSION AND CONCLUSION

In this research, the importance of the topic, and the analysis of the procedure of snowfall in Guilan province, and the recognition of the systems which lead to the snowfall, and the effective factors on the establishments of this systems are studied, and then the procedure of snowfall in the plain is analyzed based on the stations where are located.

It is important to know the regulations and patterns lead to snowfall from different point of views, and also important to recognize the application of it on the established plans and related planning's. To reach this goal, the heavy snowfalls are examined through different sides:

- The analysis of the falls from the sky in Guilan plain and the comparison of it with the snowy regions in the country.
- The analysis of the synoptic systems which lead to the snow falls and the measurement of these systems.

The analysis of the synoptic of the heavy snowfalls with the help of the synoptic plans of the middle levels of the atmosphere, and the surface of the ground in heavy snow falls, show that, all this snow falls happen in those times when then the polar low pressure has had a deep influence on the region.

In all this snowfalls, the arrangement of the patterns of pressure on the surface of the ground show that the immigrant rotators are activated, and they are under the influence of the humidity of black sea, Mediterranean and Caspian Sea with the cold weather, because of the polar low pressure. On the middle levels of the atmosphere, the arrangement of the western winds with the establishment of the low pressure and

The trough axis of this system from North to south of Caspian Sea influenced Guilan plain, especially across Sefidrood valley.

This system is derived from the pole, and causes a cold weather from the high latitudes.

The high humidity from Caspian Sea causes a heavy snowfall in the province, especially across Sefidrood valley, and mountainous areas around it. The continuity of the air in the valley and North of Alborz causes a heavy snow fall in the region.

The results of the heavy snowfalls in residential areas, especially those places where not have the expectation of such snowfall, have brought a lot of damages. The roads (ways) are blocked, and the transportation systems work slowly, the snowfalls end in crisis.

So, as a conclusion, it can be said:

1. The procedure of the snow all is not the same in all areas, and it is under the influence of the local situations. The results in different stations are varied.
2. The synoptic pattern of the heavy snowfalls are different, but in all heavy snowfalls, the arrangement of west wind isobar, and the establishment of Low pressure on the middle levels of the atmosphere is accompanied with the immigrant silicones. In all chosen samples the formed trough is across North to south of Caspian Sea.
3. In all these systems, the cold weather of the higher latitudes is caused by the cold polar weather to the region, and the cause of the humidity of the heavy snow falls is Caspian Sea.

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