

# Study of Atmospheric System and its Effect on Flood in Isfahan

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**Abstract**—Heavy rains are one of the features of arid and semi arid climates which result in flood. This kind of rainfall originates from environmental and synoptic conditions. Mediterranean cyclones are the major factor in heavy rainfall in Iran, but these cyclones do not happen in some parts of Iran such as Southern and Southeastern areas. In this study, it has been tried to pinpoint the synoptic reasons of heavy rainfall in Isfahan through the analysis of the relationship between this rainfall in Isfahan and atmospheric system over Iran and the areas around it. The findings of this study show that the major factor have is the arrival of Sudanese low pressure system in this region from the southwest, of course if the ascent local conditions such as heat occur, the heaviest rains happen in Isfahan. In fact this kind of rainfall in Isfahan has a Sudanese origin and if it is accompanied by Mediterranean system, heavier rain falls.

**Keywords**—Flood, Atmospheric Systems, Synoptic Study, Geopotential Height, Sudanese Low Pressure

## I. INTRODUCTION

**H**EAVY rain with high intensity more than the penetrability of soil causes water stream and torrential rain. Now if heavy rain occurs in urban areas it causes more danger, since the penetrability of soil in urban areas is less than that in rural areas. Considerable amount of rain convert water stream and flood in urban areas and it damages public place and buildings.

By definition synoptic climatology is the scientific study of the connection between air stream (atmospheric circulation) and superficial environment since synoptic climatology is geared to elucidating important interaction between atmospheres and superficial environment, it has theoretical and applied value. It is weighty in various braches of meteorology and geography as well. [1] Gandomker in a research investigated the synoptic culprit's heavy rain in Zayandehrood river and concluded that crossing of Mediterranean cyclone and Westerly winds are main reasons for the rain fall in headstream of Zayandehrood. [2]Hajbabaei and colleagues investigated the maps of weather of earth and middle levels of atmosphere in a research entitled investigation of synoptic torrential systems in Isfahan. They concluded that when Sudanese low pressure centre is placed on region, torrential rain is seen and when this Sudanese low pressure centre is merged with Mediterranean low pressure centre, heavy rain is seen in south and south west of Isfahan. [3]Masoodian in a research entitled recognition of synoptic condition along with Iran's heavy cloud rainfall concluded that two major circulatory pattern exist in creating one-day heavy cloud rainfall. The first one is recognized by placing high

pressure on the black sea and spread of Persian Gulf descending. The second one is accompanied by shaping descending on Iraq and penetration of Siberian ridge into Iran. In this research there is an attempt to recognize the atmosphere systems that cause heavy and torrential rain and to forecast the placement of these systems and rainfall in order to warn executives and help them in crisis management and prevention of massive destruction. [4]Fallah and etc With weather patterns in 500 HP, concluded that adaptive neural fuzzy inference system, 70 percent in many years can they predict rain. [5]Morid and Riazati concluded that the analysis relationship between precipitation and runoff, GEV methods of statistical methods and models between HEC -1 show better results. [6]Moradi Concluded that if the southern coast of the Caspian Sea, at ground level, high pressure occurs due to cold weather and in layers of middle and upper atmosphere, creating low pressure, the necessary conditions for the occurrence of heavy precipitation occurs. [7]Omidvar Showed that the combined pattern of Sudan and the Mediterranean, the most heavy precipitation in Yazd Shirkooh are created. [8]Masoodian Showed that low-pressure and precipitation patterns and runoff in the Karun basin is a significant relationship and this relationship is more frequent in winter. [9]Mofidi and Zarrin With weather patterns in levels 850, 500, 200 and 50, concluded that the hot areas of East Africa, the main source of Sudan low pressure humidity. And Maximum input of moisture from the south West. And most effective is Kohkiluyeh and Boyerahmad. [10]Masoodian and Mohammadi concluded that European high pressure – Iraq low pressure patterns have greatest affect on Iran heavy rainfall. [11]

## II. METHODOLOGY

Daily statistics of rainfall in synoptic station has been used to specify torrential rain in Isfahan. So by analysis the amount to rain from January 1th in 1951 until the end of December in 2005 the heaviest rainfall has been reported from this station. Data of sea level pressure and geo potential height of different levels were used to investigate the atmospheric systems that cause torrential rain. The following data of 500th, 700th and 850th layer have been investigated daily dimensions of these data from January 1th in 1951 until the end of December in 2005, Were 2.5 degree by 2.5 degree and 0o to 90o Northern latitude and 0o to 150o Eastern longitude. To this end daily maps of each stratum have been drawn (for each stratum 16436 maps) these data have been collated from atmosphere organization and oceanographic organization of united state.

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III. DISCUSSION

Isfahan among the industrial and the biggest cities has the second rank. It is located in a plain with arid or semiarid climate. The amount of rain is very low (annually average is 120 millimeter). Major rainfall in this city is torrential and only in some days in a year. As it was mentioned it is located in a flatland, and the slope of north and centre of region is very gentle (low). If it rains for a short time it will cause water streams. (Gandomker, 2008)

When raining, sea level pressure and geopotential height were analyzed for synoptic investigation of heavy rain in the city.

As an example synoptic status of atmosphere in sea level, status of 700th, 850th hp layer have been used. They were measured the days before the torrential rain of the December 3, 1978.

The survey of air patterns in sea level several days the December 3 and when it was raining shows these things:

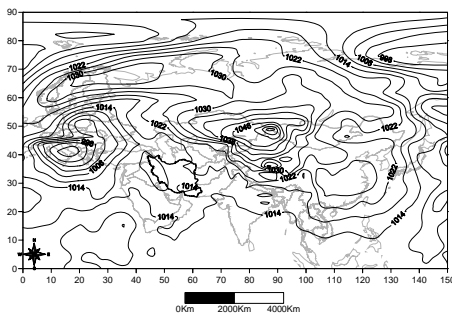


Fig. 1 Sea level pressure patterns on November 29, 1987

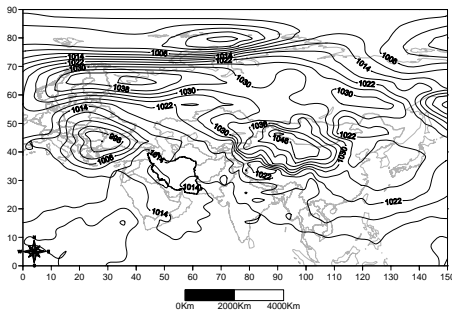


Fig. 2 Sea level pressure patterns on November 30, 1987

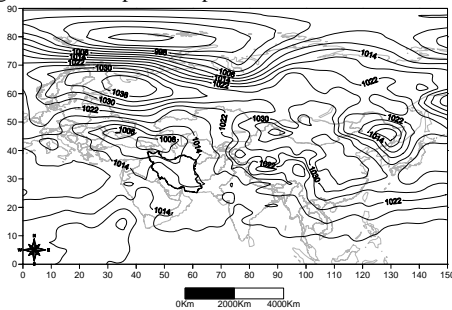


Fig. 3 Sea level pressure patterns on December 1, 1987

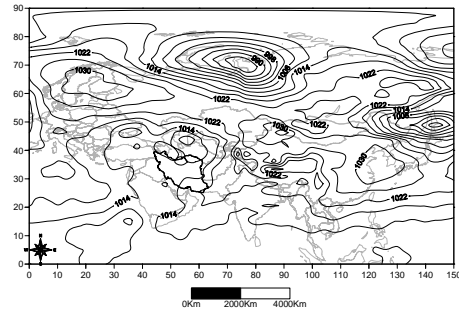


Fig. 4 Sea level pressure patterns on December 2, 1987

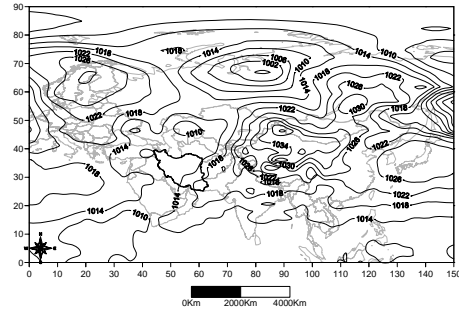


Fig. 5 Sea level pressure patterns on December 3, 1987

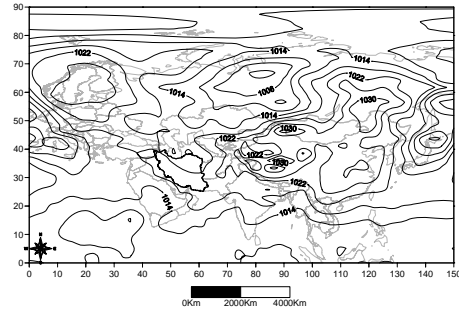


Fig. 6 Sea level pressure patterns on December 4, 1987

On November 29 a low pressure centre with a around 990 hp has been placed on Southeast of Europe. This centre is the Mediterranean low pressure centre that has formed (shaped) on Mediterranean and is moving toward Iran along with Westerly winds. As it is seen in the maps of following days centre of this system crosses the North of Iran. Simultaneously, another low pressure centre from Southwest is moving toward the centre of Iran. The amount of pressure in the centre of this system is around 1006 hp. (Fig 1 to 6) This is the Sudanese low pressure centre that has absorbed humidity from the Red sea and Persian Gulf because of its high temperature. This system is transferring humidity to the South, Southwest and centre of Iran and it will spread over North east regions as well. Zenith expanse of this system on Iran is the December 3, the day that torrential rain has occurred in Isfahan and rural areas.

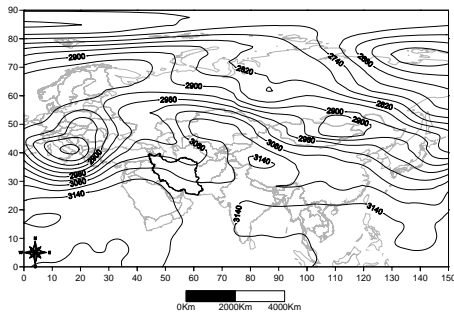


Fig. 7 Geopotential height of 700 HP patterns on November 29, 1987

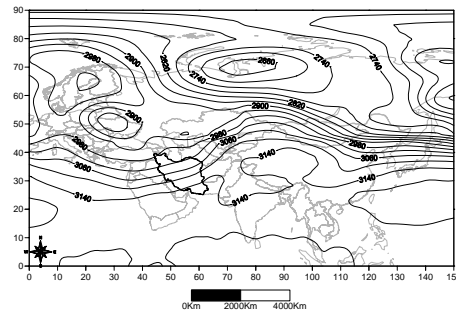


Fig. 11 Geopotential height of 700 HP patterns on December 3, 1987

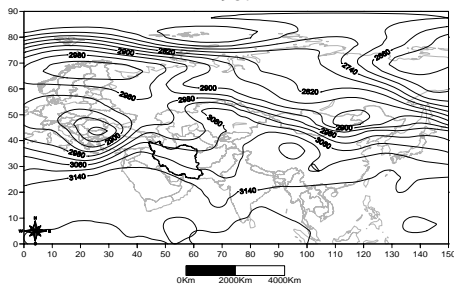


Fig. 8 Geopotential height of 700 HP patterns on November 30, 1987

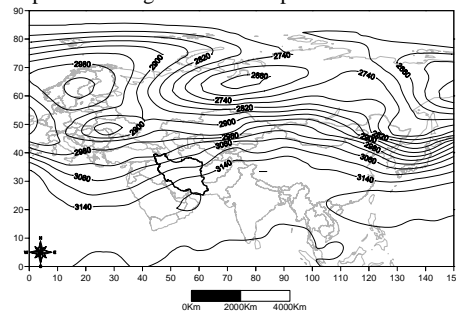


Fig. 12 Geopotential height of 700 HP patterns on December 4, 1987

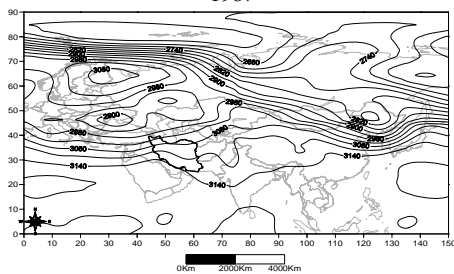


Fig. 9 Geopotential height of 700 HP patterns on December 1, 1987

In fact, simultaneous crossing of tow low pressure and wet Mediterranean and Sudanese system over Iran has transferred humidity to this region. But low Sundaes pressure has more effect on South, Southwest and center of Iran. Because the degree of temperature in December 2 and 3 has increased considerably and it has climbed to 19o C, Therefore it has brought about local ascending condition. Moreover the merging of Sudanese low pressure with weather and local ascending conditions has resulted in sudden ascending of weather and heavy torrential rain.

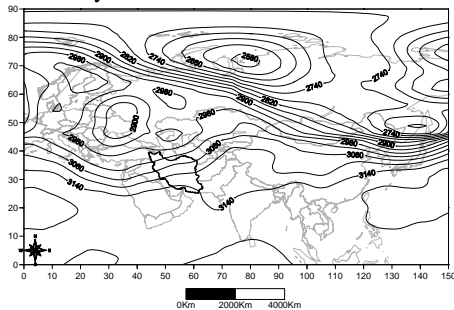


Fig. 10 Geopotential height of 700 HP patterns on December 2, 1987

Observing the last map of this level that is the December 4 has revealed that in this days the effect of those two systems has vanished away and the region is in its normal status.

Investing air pattern of 700th hp layer shows that a low centre has placed on South of Europe, and it has spread over Iran this low centre is the low centre Mediterranean system that came to Iran along with Westerly winds and Iran is under its high descending. The presence of Mediterranean high descending will cause the ascending of air in front of it. The air in this section is the wet weather of Sudanese low pressure centre that has placed on Iran. The times of the placement of Mediterranean high descending on Iran can be observed in higher layer of atmosphere. (Fig 7 to 12)

The presence of this system along with Sudanese low pressure in sea level and warm weather of earth surface will cause intensive ascending of air and torrential rain.

#### IV. CONCLUSION

Forecasting heavy rainfall in urban areas can help city planners and managers in preventing massive destruction of urban environment. Using synoptic analysis is the best and well known method to predict heavy rain. To this end, first atmospheric system that cause heavy should be recognized and the exact time of their placement should be predicted as well. Heavy and torrential rain is the main feature of arid and semiarid climate. Isfahan is located in this region too and sometimes it experiences heavy rain that brings about massive destruction of urban environment and public places and buildings.

In 1978 annual rainfall was 115 millimeter. The important point is that on the December 3 the rainfall was around 48

millimeter. This was more than one third of annual rainfall. It means that 48 millimeter out of 115 millimeter annual rainfall has occurred only in one day. This rainfall causes massive destruction.

Investigating the status of atmospheric systems before and after these rainfall shows that this kind rainfall is caused Sudanese low system that enters South and Southwest of Iran. If this system is accompanied by local ascending conditions it will cause heavy rain.

If, when Sudanese low enters Iran. Westerly winds along with Mediterranean systems spreads over Iran too the combination of these two systems can cause intensive rain like the rainfall of December 3, 1978.

#### REFERENCES

- [1] B. Yarnal, Synoptic climatology in environmental analyses, UK, London, Belhaven, 1993.
- [2] A. Gandomkarr, "Synoptic study of flood rain in middle zone of Zayanderood basin" Water resource management, October 2007, pp. 240-249.
- [3] N. Hajbabaee, "Synoptic study of flood system in Isfahan" Hazard Management, April 2006, pp. 125-136.
- [4] S. A. Masoodian, "Synoptic study of heavy rainfall in Iran" Water resource management, October 2007, pp. 420-428.
- [5] G. Fallah, M. Mosavi and M. Habibi, "Prediction of season precipitation, using synoptic patterns" Journal of Geographical Researches, Vol 66, Winter 2008, pp. 121-139.
- [6] S. Morid and D. Riazati, "Comparison of regional flood analysis models with precipitation and runoff" Journal of Agricultural Science, Vol 2, 2003, pp. 181-193.
- [7] H. Moradi, "Flood forecasting in Caspian South coastal, using synoptic analyses" Journal of Geographical Researches, Vol 55, Spring 2006, pp. 109-131.
- [8] K. Omidvar, "Synoptic analyses of precipitation in Shirkooh" Journal of Geographical Research, Vol 59, Spring 2007, pp. 81-98.
- [9] S. A. Masoodian, "Identify synoptic patterns causing major floods in the Karun River" Journal of Geography and Development, Vol 5, 2005, pp. 161-182.
- [10] A. Mofidi and A. Zarrin, "Effect of Sudan low pressure on Iran heavy flood, using synoptic analyses" Journal of Geography Research, Vol 77, 2005, pp. 113-136.
- [11] S. A. Masoodian, "Synoptic analyses of heavy rainfall in Iran" Journal of Geography and Development, Vol 19, 2010, pp. 47-70.