

## Comparative Study of the Effects of ENSO Phenomenon (El Niño, La Niña) on Temperature and Precipitation of Mashhad

V. Mohammadi Sabet<sup>1</sup> - M. Mousavi Baygi\*<sup>2</sup> - H. Rezaee Pazhand<sup>3</sup>

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**Introduction:** The Southern Oscillation is a large scale phenomenon that changes the Normal oscillating air pressure on both sides of the Pacific Ocean. It disrupted the normal conditions and the patterns of temperature and precipitation change in the nearby region and other regions of the world. This phenomenon is caused by changing the water slope in the Pacific Ocean between Peru (northwestern South America) and Northern Australia (about Indonesia and Malaysia). ENSO phenomenon is formed of Elnino (warm state) and La Niña (cold state). There is high pressure system in the East and low pressure system in the West Pacific Ocean in normal conditions (Walker cycle). The trade winds blow from East to West with high intensity. ENSO start when the trade winds and temperature and pressure balance on both sides of the Pacific Ocean change. High pressure will form in the west and low pressure will form in the East. As a result, west will have high and east will have low rainfall. Temperature will change at these two locations. Enso longs about 6 to 18 months. This research investigated the impact of ENSO on monthly precipitation and temperature of Mashhad. The results showed that temperature and rainfall have a good relation with ENSO. This relation occurs in 0-5 month lag.

**Materials and Methods:** The severity of ENSO phenomenon is known by an index which is called ENSO index. The index is the anomaly of sea surface temperature in the Pacific. The long-term temperature and precipitation data of Mashhad selected and analyzed. The Rainfall has no trend but temperature has trend. The trend of temperature modeled by MARS regression and trend was removed. The rainfall data changed to standard and temperature changed to anomaly for comparison with ENSO index. The 2016 annual and monthly temperature of Mashhad is not available. The 2016 Annual temperature was forecasted by ARMA (1,1) model. Then this forecast disaggregated to monthly temperature. For each period of occurring high ENSO, these three indexes (ENSO index, standardized rainfall and anomalies temperature) were compared. The co-variation of these indexes was compared. Also, the correlation and cross correlation for each period of occurring ENSO, with rain and temperature of Mashhad was calculated.

**Results and Discussion:** Mashhad monthly temperature and precipitation were compared with the extreme values of ENSO index in periods of the occurrence this phenomenon (1950-2016). In addition, the correlation and cross-correlation between ENSO-Rainfall index and ENSO-temperature index for this period were calculated. Forecasted temperature for 2016 by ARMA (1,1) was 13.2 Degrees Celsius, which has 0.2 degree increase in comparison to last year. Results showed that there is no an obvious relation between ENSO-Temperature and ENSO-Rainfall in interval (-1, +1). But there are good relation between ENSO-Temperature and ENSO-Rainfall beyond of (-1,+1). The results of Elnino showed that the monthly precipitation and temperature increase with a lag of 2 to 5 months and 0 to 4 months, respectively. The results of Lanina showed that the monthly precipitation and temperature decrease with a lag of 3 to 5 months and 1 to 4 months, respectively. Also when ENSO index is located in the interval (-1, +1), there is no certain harmony with temperature and precipitation of Mashhad.

**Conclusion:** The aim of this study was evaluating the effect of the ENSO phenomenon on monthly temperature and precipitation of Mashhad. Mashhad monthly temperature and precipitation, respectively, for 132 and 124 years were available. Precipitation was static and has no trend, but temperature was not static and has two changed (jumped) point in 1976 and 2000. MARS regression was used for patterning the process. Removing the trend was done by MARS model and the data was obtained without trend. Monthly ENSO index since 1950 from reliable websites worldwide (NOAA) was obtained. Mashhad monthly temperature data was animalized and precipitation data was standardized. This was performed for comparing Temperature and Rain with ENSO index. The effect of the ENSO phenomenon on Mashhad precipitation and temperature in both graphical and cross-correlation was performed. As a final result, there is a good relation with latency zero up to 5 months for temperature and precipitation of Mashhad beyond the interval (-1, + 1). It cannot be claimed that after the phase of La Nina, El Nino must be entered and vice versa. This note is important for forecasting the temperature and

1 and 2- Ph.D. Candidate and Professor of Agro Meteorology, Ferdowsi University of Mashhad

(\*- Corresponding Author Email: mousavi@um.ac.ir)

3- M.Sc. of Hydrology, Azad University of Mashhad

precipitation of 2016 coming months. If ENSO index in the coming months, especially in autumn and winter, decrease and enter in La Nina phase, the winter will be cold with low rainfall.

**Keywords:** El Niño, La Niña, Mashhad, Precipitation, Temperature

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