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A Study on ENSO Phenomenon Relationship with Fasa's Precipitation, Fasa, Iran

Ali Akbar Salehizadeh[1,*], Ameneh Benshams[1], Mohammad Rahmanian[2], Morteza Khodagholi[3]

[1]Department of Geography, Islamic Azad University, Najafabad Branch, Najafabad, Iran
[2]Geography Department, Islamic Azad University, Larestan-branch, Larestan, Iran
[3]Isfahan Agriculture and Natural Resources Center, Isfahan Province
*Corresponding author: day.system@yahoo.com

Abstract Generally, Climatic extreme events such as the heavy rainfall and sudden changes cause the greatest range of damages to water resources, agriculture and even human daily life. The decrease of negative effects of these events won't be possible except with their correct and regular monitoring. This study evaluates the effects of large-scale climate factors such as ENSO, on how occurrence and severity of seasonal precipitation changes in Fasa, Fars province, Iran. The rainfall data of a 30-year period in Fasa's station was used, and ENSO phenomenon relationship with rainfall precipitation parameter in Fasa was studied by Pearson correlation technique and other statistical methods. Monthly data was evaluated simultaneously with one-month, three- month and six-month lag. The ENSO Southern oscillation index correlation yielded that the highest ENSO phenomenon effect on Fasa's precipitation exists as concurrent reverse as much as 99% in December; in December and October with one month lag 99% and in October with 3 months lag 95%.

Keywords: *rainfall, precipitation, ENSO, pearson correlation, southern oscillation*

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1. Introduction

Linking the Persian Gulf to the Indian and Pacific Ocean waters caused it to be influenced by oceanic flows [1]. Because, the wide surface of the earth is covered by water, the oceans greatly affect on coast lines. As it is known, oceans transfer the heat along the earth, in other words they move warm waters from the equator toward poles; thus they decrease ocean energies in tropical zones. Oceans are the bed of warm and cold flows. These warm and cold flows affect on the coast line severely. The ENSO term has been derived from two terms, southern oscillation and El Niño. El Niño is the oceanic component, and southern oscillation is the atmospheric component of this phenomenon. El Niño – Southern Oscillation (ENSO) index affects on weather condition and global climate pattern. ENSO phenomenon is considered as a teleconnection pattern in planetary scales which is propagated over the southern hemisphere and a vast area of northern one. This pattern is appeared in the annual sea level pressure, temperature and precipitation. In fact, these patterns are the reflexive of ENSO phenomenon effects on severity and planetary cycles position and airflow patterns in torrid zones. More than 13 teleconnection patterns have been identified in northern hemisphere while their related data has been provided and used. ENSO phenomenon has different effects on the earth; furthermore warm phase effects (ENSO) have been evaluated. These effects includes severe draught, unusual rainfall and floods, forests fire, hurricanes, increase in tropical diseases such as malaria and other economic and social effects. Sometimes level pressure variation between Tahiti in the East and Darwin in Australia in the West side of the Pacific Ocean are used as a measurement indicator of Southern Oscillation; the positive or negative variations of this difference indicate ENSO different phases. According to the studies done El Niño causes wet-period in Iran. Meanwhile there were some years in which this phenomenon had caused dry- periods. The main reason was the polar vertex which moved toward to the east of the Urals. North Atlantic Oscillation was positive and Indian ocean Dipole was proved to be negative.

Haghnegahdar and colleagues [2], in their study entitled as "A study on El Niño – Southern Oscillation- Effects on Iran Southwest Annual Maximum Water Floods in Iran" concluded that when El Niño phenomenon occurs in February and March in Karoon and Dez river basins, AMF (Annual Maximum Flood) probability is more than the average of neutral mode. This feature is opposite for La Niña phenomenon. Also, the severity of AMF changes in El Niño is more than La Niña.

In an article which studied the effects of El Niño and La Niña on variable spring precipitation in Eastern Azarbayejan, after using Pearson correlation analysis method, Qavidel Rahimi (2005) concluded that there is a positive meaningful relationship between Nino 1+2 , Nino 3 and spring precipitation in Eastern Azarbayejan stations; it means increase in the amount of spring precipitation in El Niño (positive or warm phase) and vice versa which means rainfalls decrease in negative phase or La Niña (cold phase) [3].

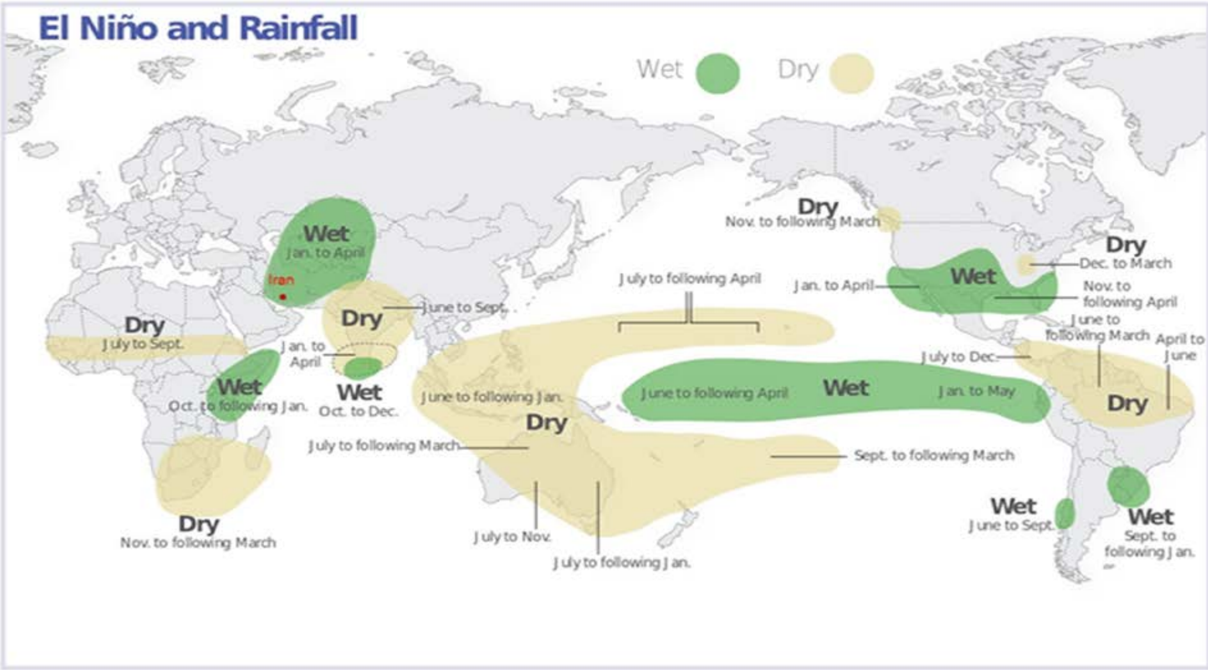

Figure 1. El Niño phase and Rainfall

Zare Abyane and Bayat Varkeshi (2012) in their paper entitled "A Study on the Effect of the Raining-days Numbers on ENSO Phenomenon in Iran Based on 30 Synoptic Stations", determined the relationship between ENSO climate index and the number of rainy days in synoptic stations in this country by making use of rainy-days zoning map and Pearson correlation analysis method. Among climate indicators, the correlation between Nino 3 index with the number of annual rainy days was obtained in most stations, while SST index stood in the second place; in contrary, PNA climate index only revealed its correlation with the number of rainy days in four stations showed; this is weak and unstable indicator [4]. On other hand comparison between annual rainy days number in ENSO warm phase (El Niño) and in its cold phase (La Niña) showed that the number of rainy days in El Niño phase has been more than La Niña which is demonstrator of an increase in the number of rainy days in El Niño phase around Iran.

Sabziparvar and Tenyan (2013) concluded in their study that warm climate shows more sensitivity to the ENSO signals than cold climatic zones [5]. Shirmohammadi and colleagues (2011), in an article studied the ENSO phenomenon relationship with extreme seasonal precipitation amount [6]. The result of ENSO with extreme events showed that the index of spring and fall precipitation enjoy the highest correlation in one month lag while the winter precipitation index showed the highest correlation amount for one-year lag.

In their study, Nazemosadat and Shiravani (2004) concluded that oscillation of NINO (especially NINO 4) has been distinguished 10% more effective than SOI in the Caspian seacoast precipitation forecast [7].

Hejazizade and colleagues (2013) in an article entitled "A Study on Climatic Signal Effect on Iran Central Zone Precipitation by the Use of Artificial Neurotic Network" concluded that among the studied signals, ENSO signal has a meaningful effect on the precipitation in Iran central zone in NINO 1.2 and NINO 3 region. 3 and 6 month lags caused the correlation coefficient to become stronger in NINO 1.2 and NINO 3 region, and a 6 month lag caused the coefficient correlation of ENSO phenomenon in NINO 1.2 and NINO 3 regions to become negative [8].

Kane(1999) in his studies mentioned that the effect of El Niño's showed some dependence on the month of commencement. In years when El Niño's showed no effect, considerable influence of other factors (e.g. Atlantic SST on Northeast Brazil rainfall) was noticed [9].

Basher and Zheng (1998) in their research on Mapping rainfall fields and their ENSO variation in Data sparse of Tropical Southwest Pacific Ocean region mentioned that the rainfall variation of a particular location are maybe understood in terms of competition of influence among the changing features of the pattern rather than as a simple linear function of the SOI [10].

Alegria and his colleagues (2011) in ENSO-conditioned rainfall drought frequency analysis in Northwest Baja California, Mexico investigated seasonal and annual precipitation data from 34 sites in Northwest Baja California. Along with the analysis of precipitation climatology and international variability, El Niño /Southern Oscillation (ENSO) and related Pacific Ocean Sea Surface Temperature(SST) patterns are shown to be potential predictors of seasonal precipitation. Analysis of precipitation variability at seasonal and annual time scales is performed using the standardized precipitation index (SPI) methodology; indeed annual, seasonal and ENSO–conditioned precipitation frequency analyses are executed using the regional L-moment algorithm [11].

In an study on ENSO relationship with the rainfall in SRI LANKA, Kane(1998) suggested that for obtaining composite maps based on El Niño years only the unambiguous ENSO of warm years may be used [12].

In an study on extremes of the ENSO Phenomenon and Indian Summer Monsoon rainfall, Kane(1998) concluded that some floods and droughts were associated with incorrect type(floods during El Niño, etc.), and some occurred during non events, indicating that factors unrelated to El Niño, or Southern Oscillation or warm or cold phase may be more influential in some years [13].

In an article entitled “Fuzzified Effect of ENSO and Macro Cycle Patterns on Precipitation on Arizona: Case Study” Galambosi and his colleagues (1999) obtained results which showed that the fuzzy rule-based model can provide a good basis for future works to downscale general circulation model results to study local precipitation under climate changes. The results of using only SOI lags or circulation patterns frequencies as inputs which are also presented here, clearly show how much the results are improved using both inputs jointly instead of only one [14].

Indeje and his colleagues in an article entitled “ENSO Signals in East Africa Rainfall Seasons” mentioned the results which showed unique seasonal evolution patterns in rainfall during different phases of ENSO cycles [15].

Phillips and Mc Intyre (2000) in their study entitled “ENSO and Interannual Rainfall Variability in Uganda: Implications for Agricultural Management by Averaging Across All Stations” mentioned that Pacific Ocean Nino3 region sea-surface temperatures (SST) from July to September are significantly correlated with both the concurrent August-September rainfall and the following November–December rainfall with opposite signs [16].

Leavitt and Wright (2002) obtained results which confirmed strong influence of moisture on tree-ring $\delta^{13}\mathbf{C}$, and supported their use in both temporal and spatial modes to infer past climate variability [17].

Kane(2000) in his research entitled “ENSO Relationship with Indian Rainfall in Different Months” concluded that in subdivisions of North East, East Peninsular and South Peninsular, effects were mixed with drought in monsoon months preceded and/or followed by or interspersed with excess rainfall in some months. In La Niña (cold events), effects were generally opposed with those of ENSO in warm events [18].

2. Materials and Methods

Fasa is located 145 kilometeres south of Shiraz, in Fars province which is located South of Iran. Adjacent cities are Sarvestan, Darab, Jahrom, Istahban. The history of this city dates back to seven thousand years ago. Fasa is involved in agricultural activities, and holds the first rank in wheat production in Iran. Thus, it seems essential to study precipitation in Fasa station. The purpose of this study is investigating ENSO phenomenon impact (El Niño and La Niña) on temperature and precipitation by using multivariate ENSO phenomenon.

Figure 2. Fasa Location on the Map

In conclusion synoptic station in Fasa is situated between 53 degree and 19 minute to 54 degree and 15 minute Eastern length, and 28 degree and 31 minute to 29 degree and 24 minute Northern width was used as a sample. The used values include Fasa Station precipitation values, multivariate ENSO phenomenon values and temperature values over a long statistical period (1976-2010). Precipitation values were obtained from Iran Meteorological Organization (www.weather.ir) and SOI values were obtained from National Oceanic and Atmospheric Administration. In order to calculate SOI, Monthly recorded pressure values in each of the two stations are standardized according to the available data sets. Then, in the next stage the difference of Darwin and Tahiti standardized pressure values is considered as SOI index.

Therefore, at first the monthly SOI data and synoptic station temperature were gathered in Fasa from 1967 to 2013.Then, monthly data were investigated by EXCEL software as concurrent data based on one- month, three-month and six-month lag. When correlation coefficients of all months were calculated and their obtained charts were provided, according to the obtained correlation coefficients, months with more data correlation probability were selected for more investigation; they were then applied in SPSS software. By making use of Pearson correlation at this stage, the amount of correlation between SOI index data and the city temperature was calculated.

$$r_{pearson} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

3. Results and Discussion

ENSO phenomenon can be specified by pressure gradient of sea surface along East-west continental region of South Pacific Ocean and also by amounts of mean deviation of sea surface in some determined parts of the ocean. Southern Oscillation Index indicates the severity of pressure gradient along East-west of Pacific Ocean. The index that represents atmospheric characteristics of ENSO phenomenon generally is calculated based on difference of standardized values of atmospheric pressure of sea surface in Darwin, Australia and Tahiti Island (located in Pacific Ocean central zone). In order to calculate SOI, Monthly recorded pressure values in each of the two stations are standardized according to the available data sets. Then, in the next stage the difference of Darwin and Tahiti standardize pressure values is considered as SOI indexed.

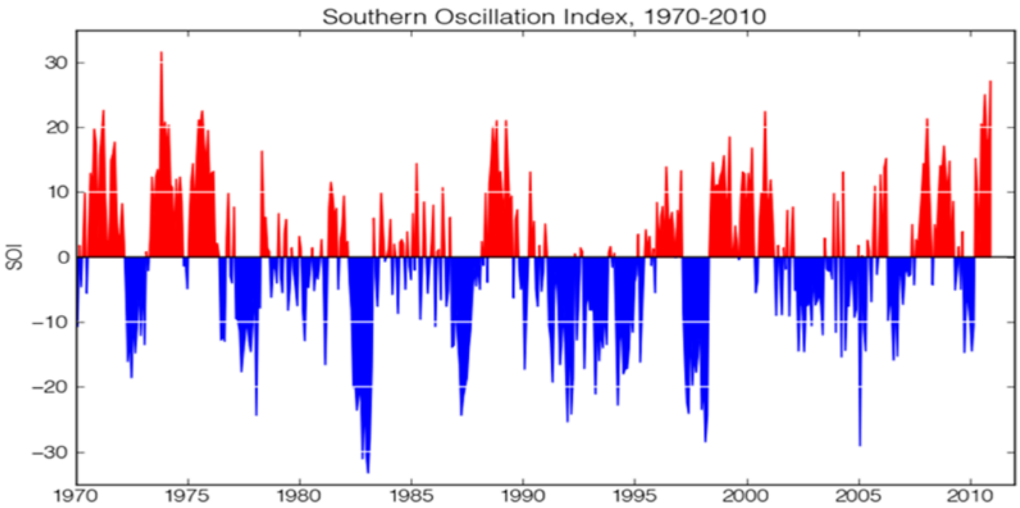

Figure 3. Southern Oscillation Index

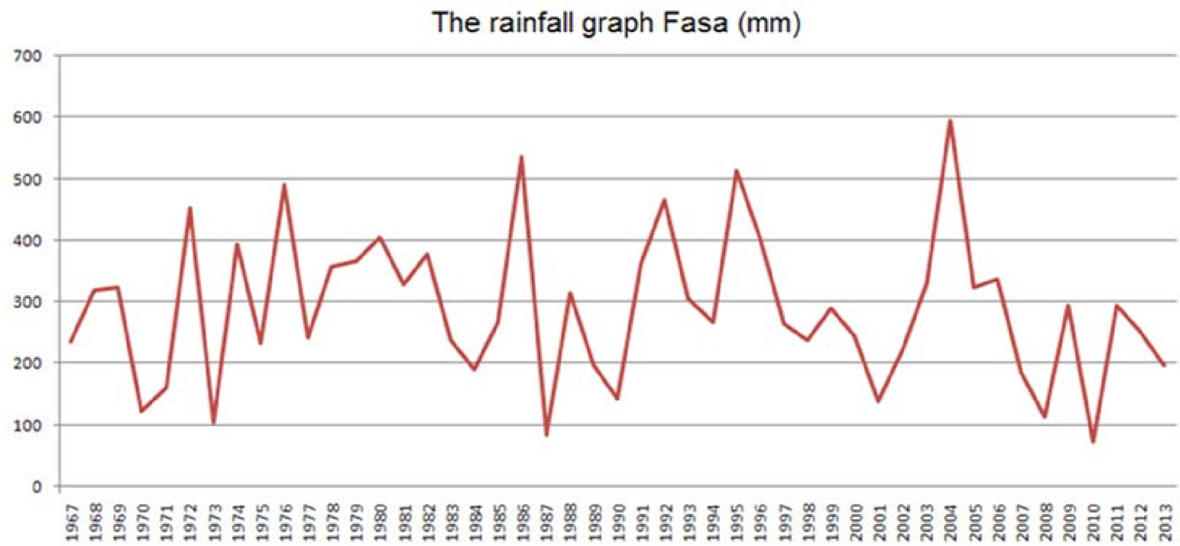

Figure 4. Fasa Rainfall Graph

4. Conclusions

The correlation between temperature and precipitation in Fasa Synoptic station is studied by Pearson method based on SOI index. The results indicate that there is no meaningful relationship between SOI fluctuations and temperature change in Fasa Synoptic station. But, concurrent SOI fluctuation index with one month lag shows an reverse correlation with 99% confidence level with precipitation amount in December. There is also reverse relationship between 95 percent confidence level with October precipitation with one month or three months lag. Indeed, no meaningful correlation was observed in a six-month lag. In general, according to the obtained results we conclude that in various periods when El Niño occurs, precipitation increases in October and December in Fasa, and the index can be used for future precipitation forecast.

Table 1. Pearson correlation of precipitation and its significance

The Inverse effect on precipitation		
Time \ confidence level	99 percent(Correlation is significant at the 0.01 level)	95 percent(Correlation is significant at the 0.05 level)
Concurrent	December	
	Sig:0.006	
	Pearson Correlation:-0.392	
One Month Lag	December	October
	Sig:0.007	Sig:0.024
	Pearson Correlation:-0.386	Pearson Correlation: -0.330
Three Months Lag		October
		Sig:0.016
		Pearson Correlation: -0.351
Six Months Lag		

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References

[1] Reynolds, R.M.(2014), Overview of Physical Oceanographic Measurements taking during the MT. Mitchell Cruise to the ROPME Sea Area Regional Organization for the Marine environment ROPME, Kuwaite. Brook_haven National Laboratory 2:78-92.

[2] Haghnegahdar, Amin and Colleagues (2007). A Study on El Niño – Southern Oscillation- Effects on Iran Southwest Annual Maximum Water Floods in Iran , *Journal of water and Sewage* , 64: 70-82.

[3] Qavidel Rahimi, Yousef , (2005), The Effect of ENSO Climate–ocean Cycle Pattern on Continental Seasonal Variety in Iran : The Effect of El Niño and La Niño on Spring Precipitation Changeability in Eastern Azarbayejan, humanities teaching periodical 9 (4):125-140.

[4] Zare Abyane, Hamid and Bayatvarkeshi , Maryam , (2012) , A Study on the Effect of the Raining-days Numbers on ENSO Phenomenon Index in Iran Based on 30 Synoptic Stations , Gorgan University of Agricultural Sciences & Natural resources, *Water and Soil Protection Journal*, 19(1): 45-49.

[5] Sabziparvar, Ali Akbar and Tenyan, Sara, (2013), ENSO Phenomenon Effect on Evaporation and Transpiration Oscillations in Several Cold Climate in Iran , *Journal of Soil and Water, Agricultural Industry and Science* , 27 (1) :.91-110.

[6] Shirmohammadi, Zahra and colleagues, (2011) , A study on the ENSO Phenomenon Relationship with the Amount of Seasonal Precipitation in Khorasan States, 15: 45-63.

[7] Nazem Al-Sadat, Mohammad Ja'afar, and Shirvani, Amin (2004), CCA Application for Evaluation and Comparison of SOI Ability and NINO's SST in the Forecast of the Caspian Sea Coast Winter Rainfall, *Journal of Agriculture Science, Technology and Natural Resources* , 8th year, 1: 46-65.

[8] Hejazizade, Zahra and Colleagues, (2013) , A Study on Climatic Signal Effect on Iran Central Zone Precipitation by the Use of Artificial Neurotic Network, *Journal of Geography Sciences Issue*, 29: 33-44.

[9] Kane,R.P,(1999), Rainfall Extremes in Some Selected Parts of Central and South America:ENSO and Other Relationships Reexamined, International Journal of Climatology.

[10] Basher, Reid.E, Zheng, Xiaogu,(1998), Mapping rainfall fields and their ENSO variation in Date_Sparse Tropical. Southwest Pacific Ocean region, International Journal of Climatology, Royal Meteorological Society.

[11] Alegria, M. Hallak and his Colleagues, (2011), ENSO_ Conditioned Rainfall Drought Frequency Analysis in Northwest Baja California, Mexico, International Journal of Climatology.

[12] Kane .R.P(1998), ENSO Relationship with the Rainfall in SRI Lanka, *International Journal of Climatology*.

[13] Kane .R.P(1998) , Extremes of the ENSO Phenomenon and Indian Summer Monsoon Rainfall, *International Journal of Climatology, Royal Meteorological Society*.

[14] Galambosi, Agnes and his Colleagues, (1999), Fuzzified Effect of ENSO and Macrocirculation Patterns on Precipitation: An Arizona Case Study", International Journal of Climatology.

[15] Indeje, Matayo and his Colleagues,(2000), ENSO Signals in East Africa Rainfall Seasons, International Journal of Climatology.

[16] Phillips, Jennifer, McIntyre, Beverly, (2000), ENSO and Interannual Rainfall Variability in Uganda: Implications for Agricultural Management, International Journal of Climatology.

[17] Leavitt, Steaven, Wright, William,(2002), Spatial Expression of ENSO, Drought and Summer Monsoon in Seasonal δ13C of Ponderosa Pine Tree Rings in Southern Arizona and New Mexico, Journal of Geophysical Research.

[18] Kane, R.P, (2000), ENSO Relationship with Indian Rainfall in Different Months, *International Journal of Climatology*.