Journal of Water and Soil
Vol. 29, No. 5, Nov.-Dec. 2015, p. 1391-1405

نشریه آب و خاک (علوم و صنایع کشاورزی)
جلد ۲۹، شماره ۵، آذر – دی ۱۳۹۴، ص. ۱۴۰۵-۱۳۹۱

# Forecasting and Analysis of Monthly Rainfalls in Ardabil Province by Arima, Autoregrressive, and Winters Models

**B. Salahi[1*]- R. Maleki Meresht[2]**

Received: 08-04-2014
Accepted: 03-05-2015

**Introduction:** Rainfall has the highest variability at time and place scale. Rainfall fluctuation in different geographical areas reveals the necessity of investigating this climate element and suitable models to forecast the rate of precipitation for regional planning. Ardabil province has always faced rainfall fluctuations and shortage of water supply. Precipitation is one of the most important features of the environment. The amount of precipitation over time and in different places is subject to large fluctuations which may be periodical. Studies show that, due to the certain complexities of rainfall, the models which used to predict future values will also need greater accuracy and less error. Among the forecasting models, Arima has more applications and it has replaced with other models.

**Materials and Methods**: In this research, through order 2 Autoregrressive, Winters, and Arima models, monthly rainfalls of Ardabil synoptic station (representing Ardabil province) for a 31-year period (1977-2007) were investigated. To assess the presence or absence of significant changes in mean precipitation of Ardabil synoptic station, rainfall of this station was divided into two periods: 1977-1993 and 1994-2010. T-test was used to statistically examine the difference between the two periods. After adjusting the data, descriptive statistics were applied. In order to model the total monthly precipitation of Ardabil synoptic station, Winters, Autoregressive, and Arima models were used. Among different models, the best options were chosen to predict the time series including the mean absolute deviation (MAD), the mean squared errors (MSE), root mean square errors (RMSE) and mean absolute percentage errors (MAPE). In order to select the best model among the available options under investigation, the predicted value of the deviation of the actual value was utilized for the months of 2006-2010.

**Results and Discussion:** Statistical characteristics of the total monthly precipitation in Ardabil synoptic station indicates that in May, the highest and in August, the lowest monthly total rainfall accounted in this station. Standard deviation of rainfall reached to the lowest level in August and its peak in November. Coefficients of skewness and kurtosis of total rainfall in all seasons, indicates a lack of compliance with normal distribution. From the view of the range of total monthly rainfall, October and August have highest and the lowest tolerance in these parameters, respectively. The results showed that the percentage of the mean absolute error for Arima, Winters and Autoregressive models was 61.82, 148.39 and 81.54 respectively and its R square came to be 88.28, 61.07 and 85.12 respectively. The comparison of the parameters is an indication of the fact that Arima has the highest R square and the lowest mean absolute error of 88.28 and 61.82 respectively than Winters and Autoregressive models. The presence or absence of significant changes in mean precipitation during 1977-1993 and 2010-1994 in Ardabil synoptic station shows that the difference of rainfall is not significant at the 5% error level from statistical point of view. The comparison between the monthly mean rainfall of Ardabil synoptic station in 1994-2010 and 1977-1993 indicates that rainfall has somewhat decreased in the former in recent years. Considering the low average monthly rainfall of Ardabil synoptic station in 1994-2010 compared to 1977-1993 (21.98 versus 26.11 mm), although no statistically significant difference was found in the average rainfall, low rainfall in this station would not be unexpected in the coming years. The comparison of predicted and actual values from 2011 to 2013 in Ardabil synoptic station showed that fitting real data with expected data was relatively acceptable. The observed differences between the actual and predicted values can be related to the influence of rainfalls and many local and dynamical factors of this area. Therefore, it is necessary for climatologists to better explain and predict phenomena besides statistical models and pay more attention to general circulation models (GCM) under different climate conditions.

**Conclusion:** Results of rainfall investigation by order 2 Autoregrressive, Winters, and Arima models showed a descending trend in monthly rainfalls in the coming years across the study location. The results of modeling and analysis of monthly rainfalls in Ardabil synoptic station showed that among these models, Arima was better than the other two because it enjoyed the lowest MAPE and the highest R2. AIC, RMSE and MAD scales of

1, 2- Associate Professor and M.Sc Graduated of Climatology, Department of Physical Geography, University of Mohaghegh Ardabili, Respectively
(* - Corresponding Author Email: bromand416@yahoo.com)

different patterns were calculated and finally, SARIMA(1,1,1)(2,0,1)12 pattern having the lowest AIC, RMSE and MAD was selected as the most appropriate pattern for monthly rainfall forecasting in Ardabil synoptic station.

**Keywords:** Descriptive statistics, Modeling, Rainfall fluctuations, Statistical tests, Validation