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Relative Humidity and Mean Monthly Temperature Forecasts in Ahwaz Station with ARIMA Model in time Series Analysis

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Abstract. In two recent decades, the resultant changes in global climate were one of the main issues propounded among water resources' experts in the country; and temperature and humidity forecasts can efficiently be applied in decision making and optimum usage of water resources. Temperature and humidity have irrefutable effects on hydrologic cycle, production cycle of agricultural products, water consumptions (specifically agriculture), human efforts and environment. Utilization of Statistical distribution is one of the main rules that have the capability of forecasting hydrologic events with largeness and distinctive incidence probability. Theory of time series is implemented by two main aims of perception or modeling random mechanisms and prospect of future amounts of series based on its past. Relative humidity and the average monthly temperature of Ahvaz synoptic station is used in present research of 20-year-old statistic. And a proper model is achieved by applying time series analysis software (ITSM) in accordance with ARIMA model and autocorrelation and partial autocorrelation method and by evaluation of all probabilistic models in terms of being static and study of parameters and types of models, in order to forecast average monthly temperature ARIMA $(0,0,1)\times(0,1,1)_{12}$ and forecast monthly relative humidity ARIMA $(0,0,1)\times(2,1,2)_{12}$ based on Box-Jenkins algorithm and after validation and evaluation of model, we determined that selection of given models was very proper and forecast of relative humidity measure and average monthly temperature is implemented in agricultural years of 2009-2010 and 2010-2011 by them.

Keywords: Mean monthly temperature, relative humidity, ARIMA, Ahwaz

1. Introduction

Iran, because has been located in the drought belt and next to high pressure sub tropical fields, possesses dry and semi dry climate and this resulted in drought in most years. Three main parameters influencing on the climate of a region and resulting in continuous drought include precipitation, average temperature and moisture. The application and importance of these three parameters resulted in studying the fluctuations and temperature changes in long term and short term in recent years by meteorological specialists. Minimum fluctuation in precipitation, temperature and moisture can impact seriously on agricultural and economical parts. Predicting the climate parameters can also be used for major and long term planning particularly alternatives for combating with disasters. In order for modeling the prediction, one must use stochastic methods and time series analysis. These methods developed fast theoretically and practically since 1970 for anticipating and control. This analysis is usually related to the data that are not independent and are consecutively interrelated [5].

Tomas and Firing were among the first people who used auto regressive models for analyzing the rivers flows [4]. Then, on 70s, such attempted continued by other investigators such as Koiompo, Klems [4], and Spoilio and Hachander [4]. One may say that the first step for practical application of time series in

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hydrology taken by Mac Croshowr and Doller. According to the seasonal properties in the parameters of river stream, Mac Croshowr and Doller chose seasonal and multiplying model ARIMA(0,1,1)×(0,1,1)12 and ARIMA(2,0,0)×$(0,1,0)_{12}$ among which, ARIMA(2,0,0)×$(0,1,0)_{12}$ determined more suitable based on Nikooei fitting test.

Hipel et al [4] and Macleod et al [4] by interpreting the auto correlation functions and partial auto-correlation, obtained the parameters of seasonal and non-seasonal models of monthly Debby of Cent Laurence River during statistical period 1957- 1860. Above mentioned studies and similar studies [4] indicated that ARIMA model for monthly series with seasonal parameters and AR and ARMA models, are more fitted for annual series lacking periodical and seasonal properties.

But time series and their concepts resulting in extended application of these models fundamentally developed by Box and Jenkins (1970, 1976) [1]. The method used by these researchers later called Box-Jenkins method and attracted the view of hydrologists.

1.1. Pacifications of studied range

Ahwaz town is located in Khuzestan and in the geographical range of 48o 40' eastern longitudinal and 31o and 20' northern transversal with 22.5 m height of sea level [2]. The average precipitation of this town is 213.4mm, average temperature is 25.2^{o}C and average relative moisture is 43% annually. Due to the geographical, climate and agricultural importance of Ahwaz, this study aims to analyze

the situation of climatic parameters, moisture and average monthly temperature, simulating and providing a model for predicting the studied parameters using time series analysis and ARIMA model in Synoptic station, Ahwaz.

2. Materials and Methods

2.1. Theory of time series models

Along with modeling a time series, or on the other hand describing the behavior of a time series mathematically, there are considered three main stages [6].

- Recognizing the initial model;
- Estimating the parameters of detected model;
- Properly studying the model.

2.2. Methodology for making the model

Method of this study is conducted by time series analysis, one of these methods called ARIMA method or Box- Jenkins model or (p,d,q) mode [5]. In any (p,d,q) model, p indicates the number of autoregressive, q is the number of mobile mean and d is the order of differencing as well as indicating the number of orders needed for attaining the series to a kind of statistical balance. In the first stage, the analysis of initial values of p, d and q is determined by auto correlation (ACF) and partial auto correlation (PACF). By accurately studying the ACF and PACF charts and their components, the general view for presence of time series with trend and its properties is obtained. Then in the second stage, it is examined if p and q values, indicating the autoregressive and mobile mean, remain in the model or must be removed from. In the third stage, it is reviewed whether the residual values, residual error are random and with normal distribution or not. In this case, one can say that this model enjoys proper fitness. When time series is of type seasonal, in this state, modeling is dimensional and in the season, a part of time series changes is for changes in any season and other part to changes between different seasons. A special type of seasonal models indicating the proper results and adapted to the general structure of ARIMA models according o Box- Jenkins (1976) called multiplied seasonal model. This model is ARIMA (pdq) (PDQ). Then for ideal model, it must be used models for testing the model and comparing them to select best model for prediction [6].

2.2. The criterion for choosing the model

In time series, or generally data analysis, there might be used several proper models for indicating a set of given data. When applying the ARIMA model, Akaike Information Criterion (AIC) has higher accuracy and comparing two ARIMA model for choosing best fitting model provided can be operated better [6]. In this study, for modeling the precipitation and temperature as well as examining their effects on each other, there has been used ARIMA model using ITSM software and AIC test. According to this test, any rank with least

AIC value predicted ideal. After determining the type of model and its parameters as well as determining the value of proper AIC, for calibrating and validating the model, arable years 2005-2006 and 2007- 2008 have been considered as control and actual values compared with predicted values. Along with affirming the model there was also used efficiency factor (EF) as well as coordination of actual and predicted values. This factor indicated the model's efficiency with range of -∞ to 1 and the closer the efficiency factor to one the better the model is [7].

3. Results and Conclusion

3.1. Modeling and Predicting the average monthly temperature and humidity

3.1.1 Average monthly temperature

Using ITSM software, the auto-correlation and partial auto-correlation chart was drawn to determine the initial model; according to these charts, the regular seasonal changes can be seen in time series. The time series changes repeats in any 12 times observation; consequently, this series is not static and comes with seasonal changes, 12. Because variability of time series is increased over time, therefore, data series is not stable in variance and seasonal changes 12 made stable based on Box-Cox. For modeling by ACF and PACF, a proper model obtained for estimating the average values of temperature of Ahwaz station was ARIMA (0,0,1)(0,1,1)12. To verify the resulted model, there was used ACF and PACF chart of residuals (figure1); upon which, ACF put in the range zero and the assumption of independency and stochastic data was accepted. For validating the model, the correlation between actual and predicted values indicated in figure (2). Finally, there obtained the diagram for actual and predicted values of average temperature for 2008-2009 and 2009-2010 according to the time modeling and drawn in figure (3).

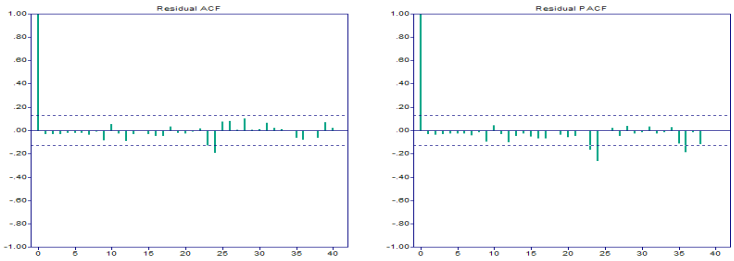

Fig. 1: ACF and PACF diagram for residuals of average precipitation against temperature in Ahwaz

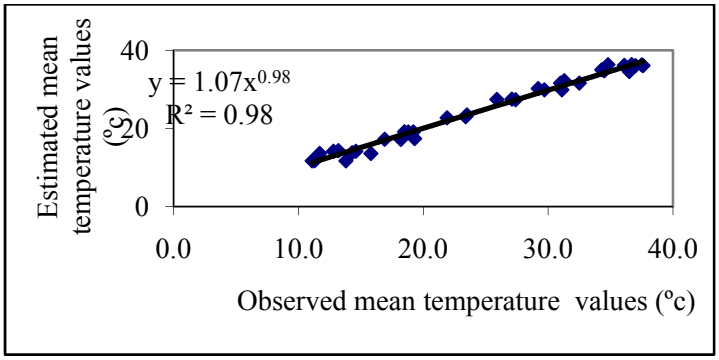

Fig. 2: Correlations between actual and predicted values of average temperature

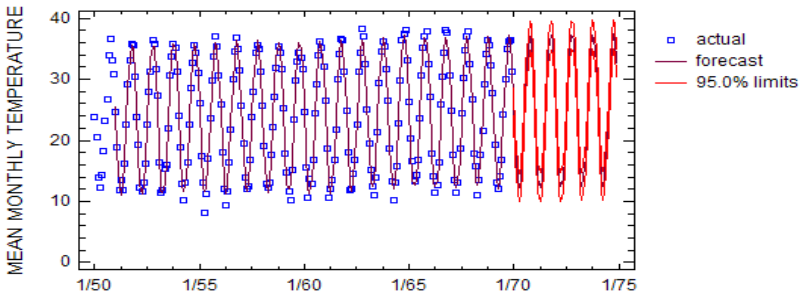

Fig. 3: Diagram for average actual temperature and predicted values using time series model

3.1.2 Monthly Relative Humidity

The ACF and PACF diagrams were initially drawn to determine the initial model. After stabilizing the data, the residual PACF diagram indicated in figure (4). The proper model obtained for predicting the value of monthly relative moisture for Ahwaz station is ARIMA $(0,0,1)\times(2,1,2)_{12}$. Along with model validation, the correlation of actual and predicted values indicated in figure (5). Finally, the diagram for actual and predicted values for 2008-2009 and 2009-2010 was drawn using time series model. Finally, diagram for average actual temperature and predicted values for 2008-2009 and 2009-2010 based on time modeling obtained is given in figure (6).

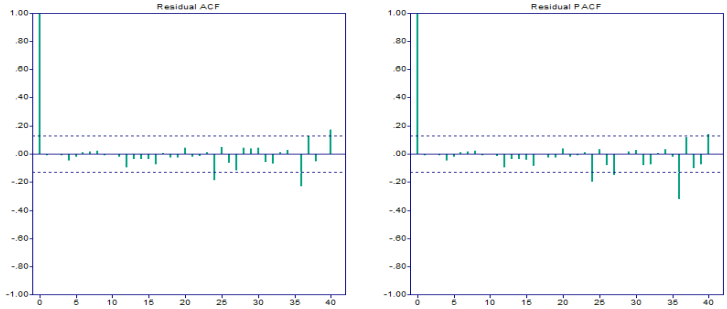

Fig. 4: ACF and PACF diagram for residual relative moisture in Ahwaz Station

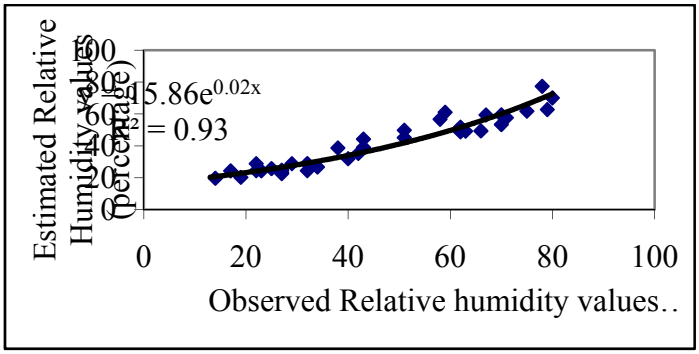

Fig. 5: the correlation between actual and predicted values of relative humidity in the station

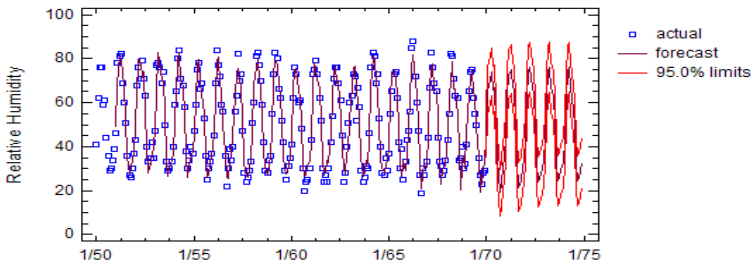

Fig. 6: Diagram for actual relative moisture and predicted ones using time series model

4. Conclusion

Recognizing these fluctuations during statistical period and predicting them are necessary for planning. Results from reviewing the climatic parameters of moisture and average monthly temperature with reviewing the diagrams indicated that:

- In order for predicting the studied parameters, there was used Box-Jenkins model and finally they assessed by providing final model. For assessing the given value model there was obtained the (EF) model for average temperature, 0.99 and relative moisture, 0.93 and this indicating the higher efficiency of model. The correlation coefficient for average temperature, 0.98 and relative moisture, 0.93 was obtained. Therefore, considering the higher accuracy of model, one can use it for anticipating the average monthly temperature and moisture.
- There was used Akaike criterion for choosing the model. According to Akaike Information criterion, $AIC(p,q)=N\ln(\sigma_\varepsilon^2)+2(p+q)$ [3]. ARIMA (0,0,1)×(0,1,1)12 model for average monthly temperature and ARIMA(0,0,1)×(2,1,2)12 model for monthly relative moisture of Ahwaz station possess smaller Akaike criterion than other models and can be chosen as models better than other seasonal models of Box-Jenkins.

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