Climatic Change Scenario(2007-2037) For TuzKhormatoo Region

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Abstract

The estimation of minimum temperature, maximum temperature, humidity and precipitation and all other climatic variables needs a range of models depending on the time scales involved. In this research a comprehensive models to generate minimum, maximum temperature and humidity based on monthly mean values for TuzKhormatoo region were developed for 30 years ahead .All these models were depended on a previous monthly data which were documented for the period (10/1978-12/2009). The Stochastic weather generator (SWG) models were used to compute the climatic variables by adjusting the parameters appropriately for the future climates factors and then by using them to estimate maximum, minimum temperature and humidity .It was concluded from this research that there will be an increase in the monthly mean values of the maximum and minimum temperature values of this region in the future. It was concluded also due to the generation process that there is a need for highly correlated climatic variables to build such model .

Keywords: SWG,Stochastic ,L0CC,L1CC,Autocorrelaton .

التغييرات المستقبلية في مناخ مدينة توزخورماتو للفترة (2007-2037)

الخلاصة

من المعلوم ان التخمين الحقيقي أو البناء المتكامل للنماذج الرياضية التي تمثل عوامل المناخ المختلفة كدرجات الحرارة العليا والصغرى والرطوبة النسبية ومعدل الامطار تحتاج سلاسل زمنية متكاملة . في هذا البحث تم بناء نموذج رياضي متكامل لتوليد بيانات خاصة بالمعدلات الشهرية لدرجات الحرارة العليا والصغرى وكذلك مقادير الرطوبة النسبية لمدينة توز خورماتو الواقعة جنوب مدينة كركوك وشمال مدينة تكريت تقريبا بالاعتماد على بيانات موثقة من قبل دائرة الانواء الجوية في بغداد ودائرة الانواء الجوية في مدينة توز خورماتو للفترة الزمنية (2009/12-1978/10) . تم استخدام طريقة ال SWG stochastic (weather generation) لتوليد البيانات المستقبلية للعوامل المناخية المذكورة بعد إيجاد المعاملات الضرورية المشتقة بعد استخدام هذه الطريقة لفترة زمنية مقدارها 30 سنة . تم الاستنتاج من خلال هذه الدراسة على زيادة واضحة في المعدلات الشهرية لدرجات الحرارة العليا والصغرى كما تم الاستنتاج اثاء عملية توليد البيانات المستقبلية إلى ضرورة وجود معامل ارتباط عالي بين العوامل المناخية التي تتولد باستخدام هذه الطريقة.

Introduction

The historical climate record is inadequate due to short or incomplete data records. One of the major gabs in the design and operation of hydrological systems is the quantification of uncertainty as a result of climatic variability. The stochastic weather generators(SWGs) is the most commonly used method to provide climatic data for locations were

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weather data are not routinely collected(Johnson et al.1996, as was cited by J.Remond et.al.2010).

Climatic data are frequently needed to aid the design of the hydraulic structures, to evaluate effects of watershed changes on hydrology, water quality or erosion or to asses alternative crop or range management strategies. Mathematical models of the physical processes involved are often used to make these evaluations. In addressing the response of these processes climatic inputs ,it is seldom sufficient to examine only responses to observed weather events. Use of only observed sequences gives a solution which is based on only one realization of climatic process. For some locations(such as TuzKhormatooat)no climatic data are available to make desired assessment . It is desirable to have capability of generating synthetic climatic data with the same statistical characteristics as the actual weather at the generating sample(Gene-Hua Crystal Ng et.al 2010).

In this research , method of SWG was used to generate(min,max monthly mean temperature, humidity) for TuzKhormatoo region near Kirkuk city .TazaKhormatoo region lies on(44º 65¯ N) and (34 º 93¯ E) 220m S.L south of Kirkuk and approximately north of Tikrit .The historical data of this region was documented on (annual,monthly,daily) base for different periods, this data were arranged after investigation of any error records and discarding if any exists.

Description of the generation process:

The SWG used in this research is based on the well known and commonly used WGEN(Richardson&Wright 1984).By using a number of parameters estimated from observed data for monthly (Tmax,Tmin,humidity),The model traditionally generates the monthly values of the mentioned variables for 30 years ahead after the process of stochastic analysis for each climatic variable. This operation was done successfully and then the cross correlation between these variables in TuzKhormatoo region were found and the corresponding model was built by using the following equation :

$$X_i = AX_{i-1} + Bx_i \quad .....(1).$$

This equation was given by Matalas as was cited by (R.Srikanthan .et al 2001), (C.Flecher .et.al 2010)&(Malika Khalili et al 2007),where X_i is a (3x1) matrix containing the current monthly standardized values of Tmax,Tmin and humidity and X_{i-1} is a(3x1) matrix containing the previous months standardized values of T max,Tmin and humidity and x_i is a(3x3) matrices of independent stochastic components of the same mentioned climatic elements and A&B are The model parameters given by:

$$A = M_1 M_0^{-1} \quad .....(2).$$

$$BB^T = M_0 - M_1 M_0^{-1} M_1^T \quad .....(3).$$

M_0 is (3x1) matrix of lag zero cross correlation (L0CC) and M_1 is(3x3) matrix lag one cross correlation (L1CC),(R.Srikanthan .et al 2001)& (A.G. Birt.et.al 2010).Using the above parameters after finding them

by using the above eq's led to generate a 30 years monthly values of Tmax,Tmin and humidity then the completion of the validation operation on the generated data was done later as will be described in the next sections .

Description of recorded data

The recorded minimum temperature ,maximum temperature ,humidity and rainfall,solar radiation data were documented daily from period 1989-2009while the data for period before were documented for monthly base (Meteorology Office in Tuz khormatoo) , (Meteorology Office in Baghdad) ,(Aldawoody 2003),there for the monthly mean value for all variables were observed as shown in figures (1-3) .

Observed Results

The Stochastic weather generation for climatic variables as it is well known requires a brief analysis of climatic variables and a good investigation about the auto correlation between these climatic variables in order to ensure the success of the operation of the generation , this fact was ensured due to this research since the analysis was done for other variables rather than max,min, temperature and humidity such as precipitation and solar radiation then the auto correlation or the cross correlation between these variables were found and tested, the most correlated variables were found to be the max,min temperature and the humidity in the TuzKhormatoo region , Table (1) expresses this fact by showing the correlation between the selected variables the shown values in the table express the recent time correlation lag zero (L0CC)or M_0 between the variables in the same region which is TuzKhormatoo (max,min temperature,humidity)and the lag 1 month correlation (L1CC) or M_1 between the same variables. :

Values which are shown in the table (1) were used as was explained in the previous section by using eq's (2,3) to find the general parameters of the TuzKhormatoo region model ,these parameters can be used for other operations such as forecasting for an other future periods and back casting operation which means estimation the data for the same variables for past times .The parameters are shown below :

A=

0.3586	0.0657	-0.0046
0.0820	0.3325	0.0298
-0.0564	-0.132	0.2266

B=

0.9100	0.1255	-0.0830
0.1255	0.9205	-0.0822
-0.083	-0.082	0.9430

As was mentioned the above parameters were used to generate the maximum ,minimum temperature and the humidity monthly values for TuzKhormatoo region for 30 years ahead this means the monthly mean values for the period (10/2007-10/2037).The operation was done by using a suitable computer order to generate a random series for desired period with 0 mean and standard deviation value equal to 1 .the generated series were used with addition to the observed parameters to describe the real values of the maximum, minimum temperature and the humidity monthly mean values by re-building the mentioned variables series taking in the consider that the built series must reflect the mean and variance of the

past time series for each corresponding variable .In the steps above it was very important to ensure the conformity in the statistical properties and statistical distributions between the generated and actual or recorded data (C.Howe,et al,2005) ,this was proved due to some statistical tests.The generated series for the three climatic variables are shown in figures (4-6).

The three generated models for the maximum and minimum temperature and the humidity were tested for validations of these models. T-test succeed in all generated series.

F-test succeed for the maximum and minimum temperature only.

Kolmogorove-Simrnove-test for comparing the distributions of the each generated variable and the recorded one ,succeed in comparison of the max ,minimum temperature but failed in comparison of the humidity.

Figures(7-9) show a comparison between the recorded and generated one of each climatic variables.

The monthly mean values of maximum and minimum temperature with the monthly mean values of the humidity for the period of (10/2007 till 12/2009) were used in the validation test (above tests). By referring to the above results it is obvious that the SWG scheme was capable to reflect the (max,min temperature,humidity) structure for the future periods in this region and the model parameters were highly sensitive to the errors in the auto correlation estimation.

Conclusions :

1-The generated scenarios of the minimum temperature values showed an increase in the monthly mean values about 1.044 (the overall mean values were 16.5,17.23 respectively for the recorded and generated data) while the maximum value for the recorded data was=36.4,and =35.123 for the generated data also the values of the standard deviation were respectively=9.82,9.78.But it is important to mention that this increasing is so normal since the statistical tests which include a comprehensive tests on the mean ,variance, over all mean, overall variance, indicated to the success of the model .

2-The maximum value of the generated maximum temperature value was = 49.67 while for the past recorded data was 48 which means also an increase of 1.0208 ratio and standard deviation values were for the generated maximum temperature data was= 9.402,and for the past recorded data =11.13 and the over all mean value for the maximum temperature were respectively =33.59,30.22 for the generated and the past recorded data this means also an increase in the maximum temperature values, which is also so normal due to the high correlation between the minimum and maximum temperature

3- The humidity generation show a reduction in the humidity values since the maximum value of humidity in the generated series was = 49.669,while the maximum value in the past recorded data was=94 ,the values of the means and standard deviation were different also since the standard deviation value for the generated data =9.4029while for the

past recorded data =17.94, the mean values were respectively =33.59,40.77.

4- the difference or the reduction in the monthly mean humidity values may be due to the small correlation between the humidity and the other two variables which are the maximum and the minimum temperature values which were highly correlated.

Notations

Max temp: Maximum temperature
Mintemp:Minimum temperature
L0CC:lag zero month cross correlation
L1CC: lag one month cross correlation
SWG:Stochastic weather generator

References:

[1] A.G. Birt, M.R. Valdez-Vivas, R.M. Feldman,C.W. Lafon, D. Cairns, R.N. Coulson, M. Tchakerian, W. Xi .2010" A simple stochastic weather generator for ecological modeling " http//.www.linkinghub.elsevier.com/ retrieve/pii/S1364815210000526

[2] C.Flecher ,P.Naveau,,D.Allared&N.Brisson 2010" A stochastic daily weather generator for skewed data" WATER RESOURCES RESEARCH, VOL. 46, W07519, 15 PP., 2010

[3] C.Howe ,R.N.Jones,S.Maheepala,B.Rohodes. 2005"Implications of potential climatic change for Melbourne water resources" A project between Melbourne water resources CSIRO Urban water and climate impact groups Doc:CMIT: 2005-106.

[4]Gene-Hua Crystal Ng, Dennis McLaughlin, Dara Entekhabi, Bridget R. Scanlon.2010" Probabilistic analysis of the effects of climate change on groundwater recharge" WATER RESOURCES RESEARCH, VOL. 46, W07502, 18 PP., 2010

[5] J.Remond ,S.C.Muller,C.sichelter andB.Rihim 2010"The use of metronome weather generator for climatic change studies" EMS Annual Meeting pro Vol. 7, EMS2010-417, 2010 ., 10th EMS / 8th ECAC

[6]Malika khalili,Francosr Brissite,and Robert loncote 2007"Stochastic multi site generation of daily weather data "Stochastic environmental research and risk assessment Vol 23 number 6, 837-849.

[7]R.Srikanthan and T.A.McMahon ,2001 "Stochastic generation of annual ,monthly and daily climatic data" hydrology and earth system sciences,5(4),653-670.

[8]Richardson CW ,Wright DA (1984) WGEN:A model for generation daily weather variables .US Dept .of Agriculture,Agriculture research service,Publ.No.ARS-8,Washington,DC.

[9] الـــداوودي ,ماهيـــة محســـن حســـن 2003 قضـاء الطـوز دراسـة فـي جغرافيـة السـكان رسـالة ماجسـتير كليـة التربيـة , جامعـة صلاح الدين.

Table(1)
The L0CC & L1CC between all climatic variables

Variables	Min Tem&it self	Min Tem&Max Temp	Min Tem&Humidity
L0CC	1	0.3258	-0.2334
L1CC	0.3811	0.1836	-0.1038
Variables	**Max Temp&MinTemp**	**Max Temp&it self**	**Max Temp&Humidity**
L0CC	0.3258	1	-0.236
L1CC	0.1834	0.3522	-0.0678
Variables	**Humidity&MinTemp**	**Humidity &Max Temp**	**Humidity&It self**
L0CC	-0.2334	-0.236	1
L1CC	-0.1524	-0.204	0.271

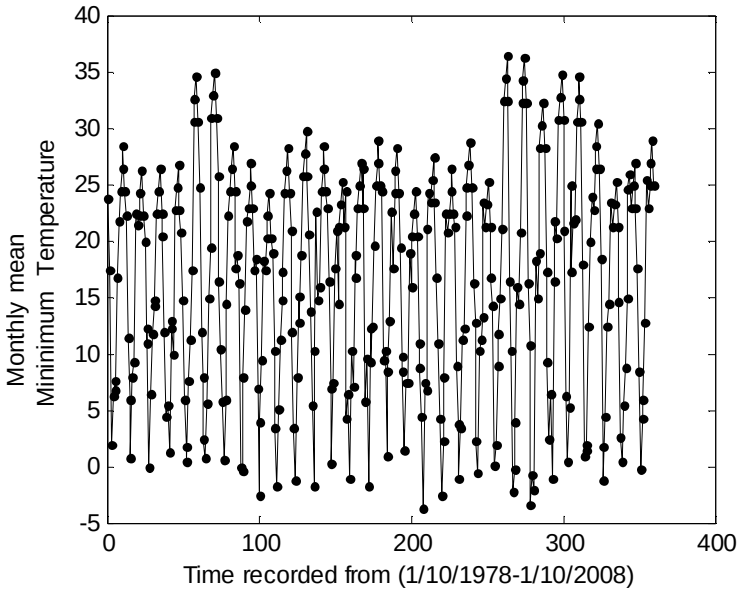

Figure (1) The monthly mean value for minimum temperature For (1978-2008)months.

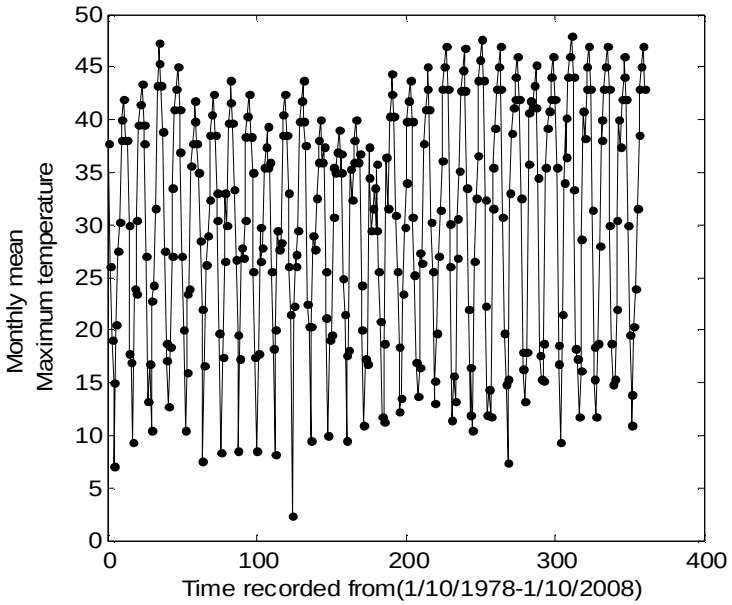

Figure (2) The monthly mean value for maximum temperature For (1978-2008)months.

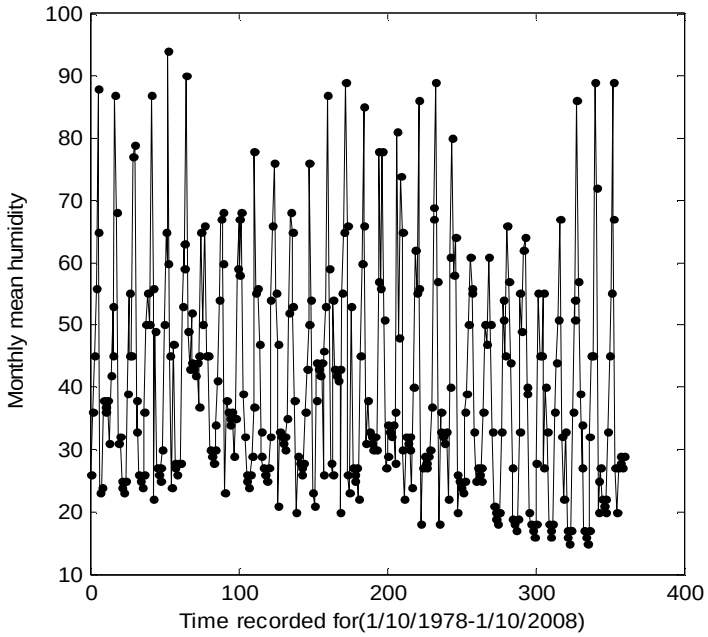

Figure (3) The monthly mean value for Humidity as a percentage for (1978-2008)months.

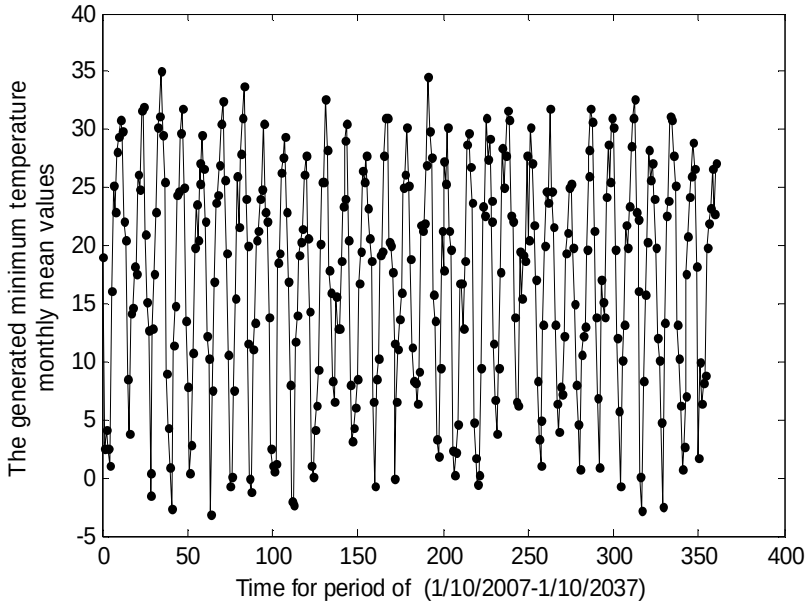

Figure (4) The monthly mean value for minimum temperature values For (10/2007-10/2037)months.

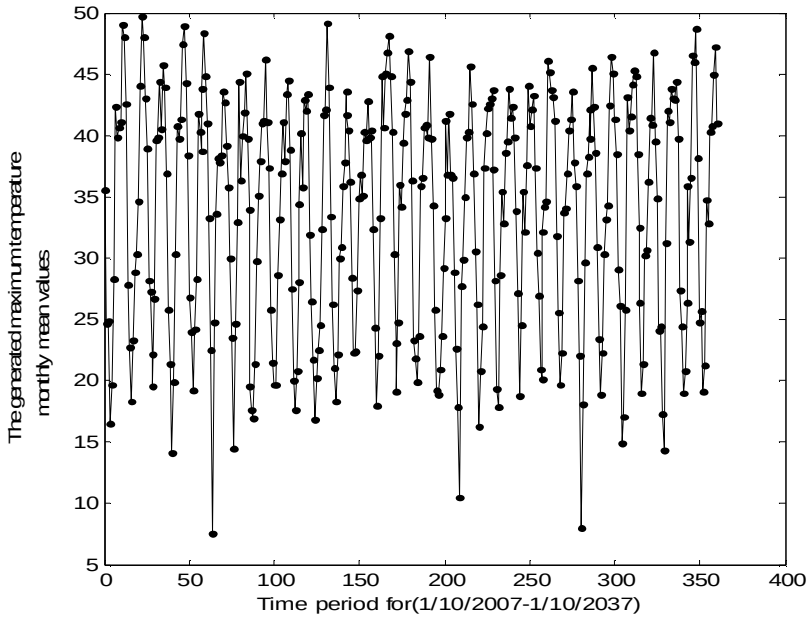

Figure (5) The monthly mean value for maximum temperature values For (10/2007-10/2037)months

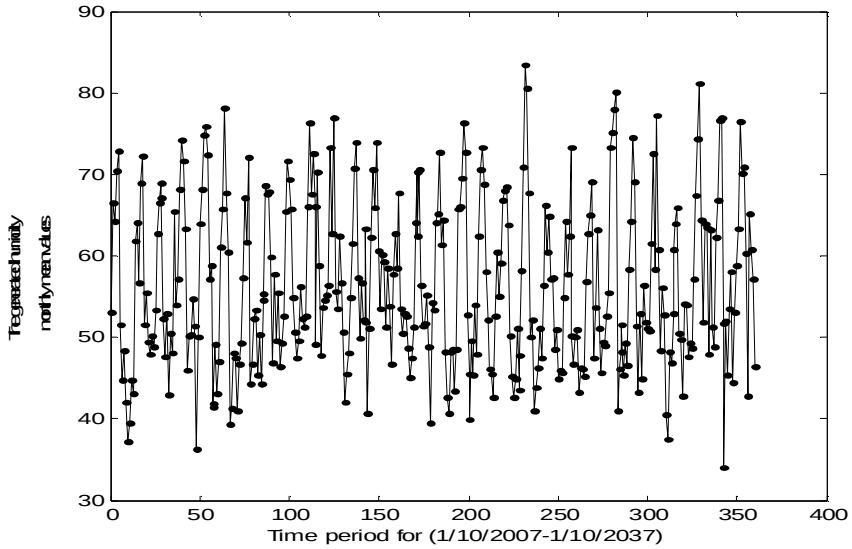

Figure (6) The monthly mean value for humidity as a percentage for (10/2007-10/2037)months.

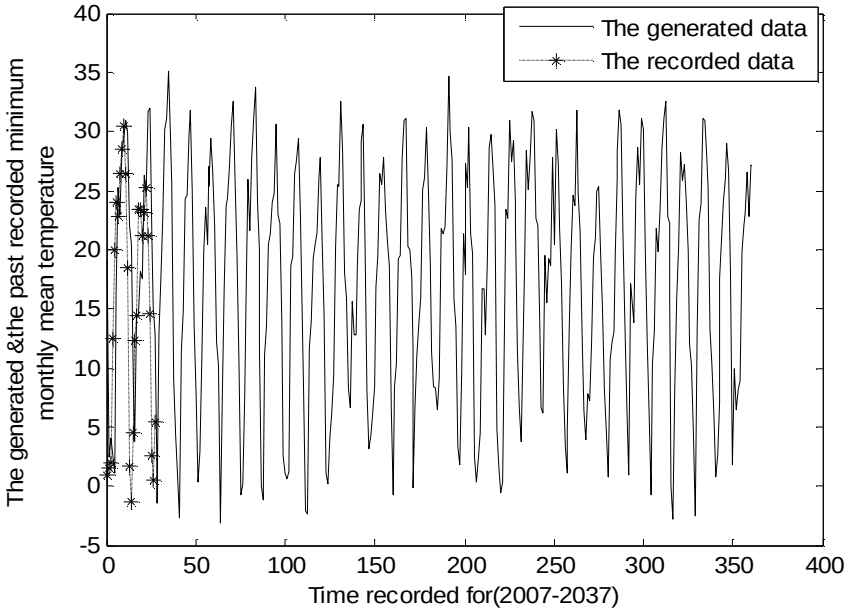

Figure (7) The comparison between the generated and the past recorded monthly mean value for minimum temperature

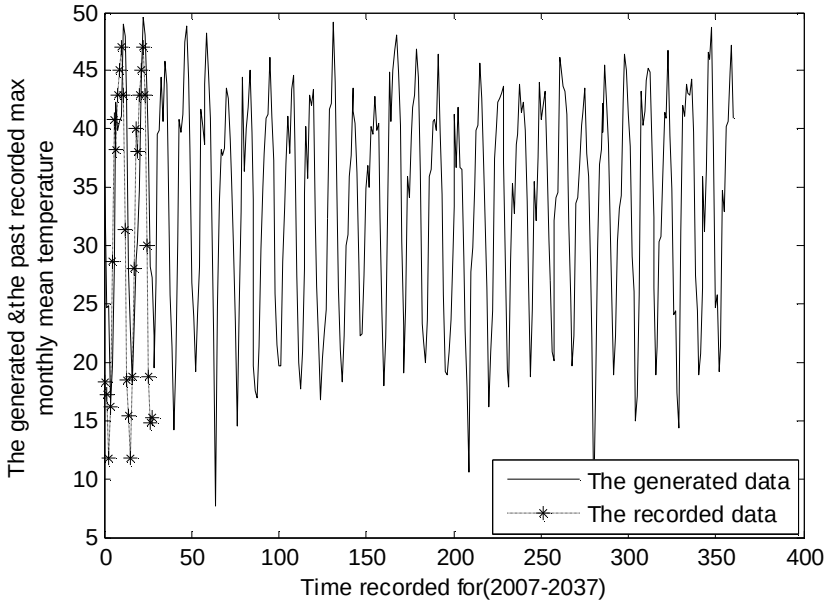

Figure (8) The comparison between the generated and the past recorded monthly mean value for maximum temperature.

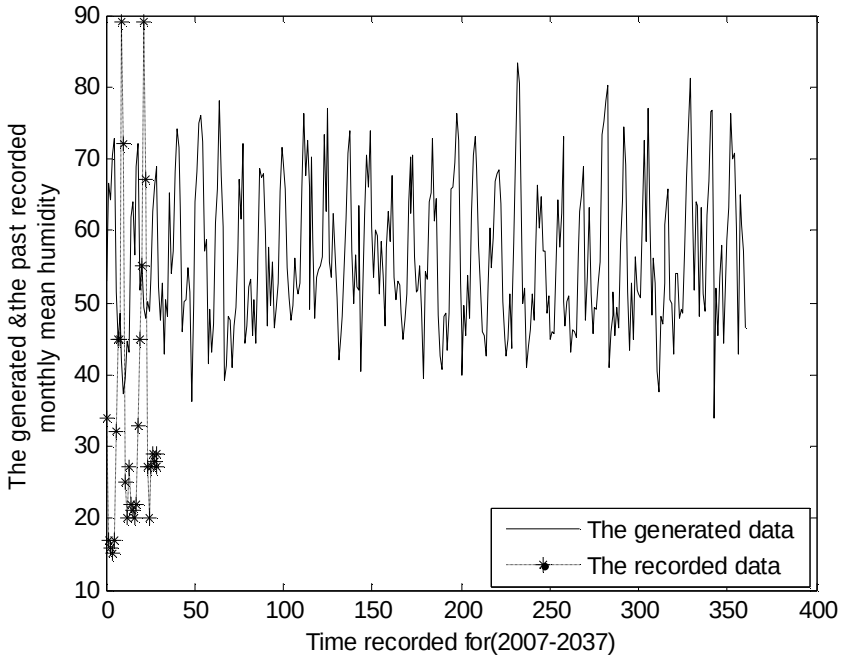

Figure (9) The comparison between the generated and the past recorded monthly mean value for the humidity values as a percentage.