Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2011, 2 (2): 128-133

ISSN: 0976-8610
CODEN (USA): AASRFC

Prediction of Rain-fall flow Time Series using Auto-Regressive Models

SK Khadar Babu[1], K. Karthikeyan[2], M. V. Ramanaiah[3] and D. Ramanah[4]

VIT-University, Vellore, TN
School of Advance Science (SAS), S.V. University, Tirupathi. AP.
Department of Statistics, S.V. University, Tirupathi. AP.

ABSTRACT

Rain-fall flow data of a meteorological station like Vellore in Tamil Nadu have been used for mean monthly flow of rain-fall data using auto regressive approach. These approaches can be used for regenerating the future sequence preserving the inherited properties of the observed data. The main statistical properties used for these purpose are mean, standard deviation and the serial correlation coefficients. The comparison of the observed rain-fall flow and the synthetically generated data shows that the statistical characteristics are satisfactorily preserved.

Keywords: rain-fall flow, ARMA, forecasting, Vellore district.

INTRODUCTION

The increasing demand of energy, the growing environmental concern and rapidly depleting reserves of fossil fuel have made planner and policy makers think and search for ways to supplement the energy base with renewable energy sources. In Vellore, a lot of hourly rain-fall flow data is been collected by Automatic Weather Station (AWS) at VIT-University campus (ISRO119) Vellore, TN. Designing a proper rain-fall flow system requires the prediction of average rain-fall flow statistical parameters [1]. Besides, these parameters important for designing wind sensitive structures and for studying air pollution.

In the auto-regressive processes where, persistence is present, that is the even out come of the future is dependent on the present period magnitude. The Auto Regressive Moving Average (ARMA) processes represent a system of elements moving from one state to another over time. In a MARKOV processes, the order of the chain gives the number of times steps in the fast influencing the probability distribution of the present state, which can be greater than one [2]. The MARKOV chain modeling approach has frequently been used for the synthetic generation of the rain-fall data. Thomas and Fiering [3] used a first order MARKVO chain model to generated stream flow data. Srikanthan and Mohan [4] used and recommended a first order MARKOV chain model to generate annual rain-fall data. Shamshad *et al* [5] compared performance of stochastic approaches for forecasting river water quality. However a few studies have been done on the synthetic generation of rail-fall flow data using ARMA approach.

ARMA approach is generally used for modeling and simulation of rain-fall flow data. In this study, the synthetic time series are generated using monthly average rain-fall flow data of about three years from 2008 to 2010 (Nov). The AWS is in VIT-University campus located at latitude:12^{0}91’ and longitude:79^{0}14’ measured at different ground levels (fig 1). In order to forecast the future mean rain-fall flow based on the previous observed information ARMA was used (table 1).

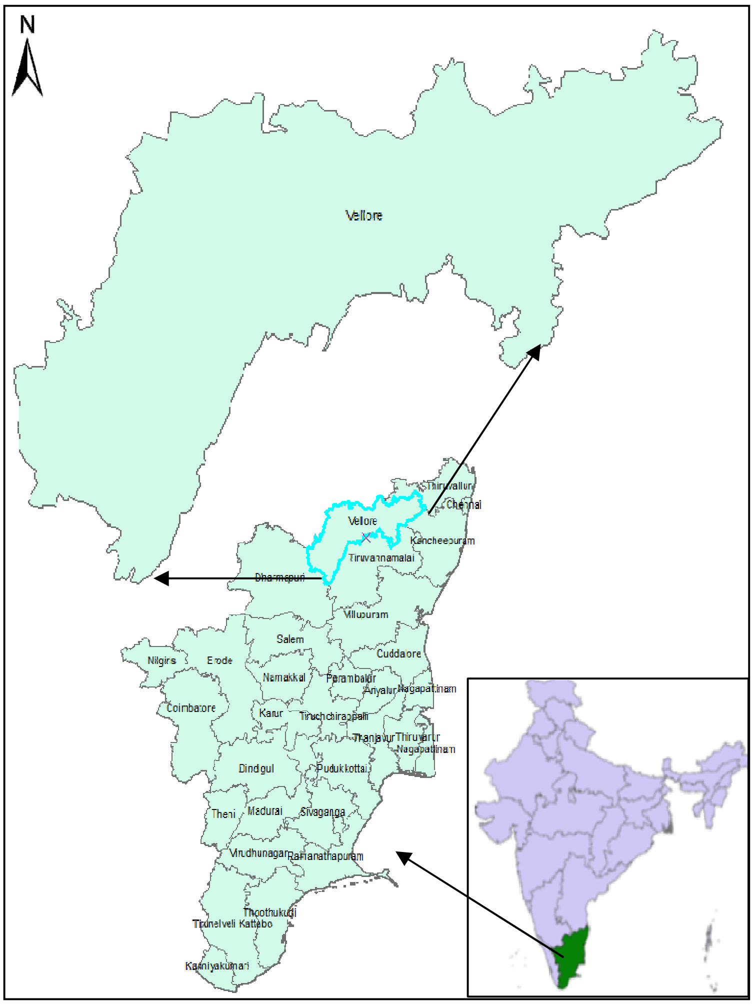

Fig 1. Study area

Table 1: Data from AWS-VIT-Vellore Station

Week	Month	Rain-Fall
	2008 -Aug	
1		1631.875
2		1640.536
3		1672.28
4		1694
5		1694.542
	2008-Sept	
1		1727.272
2		1759.22
3		1768.708
4		1784
5		1789
	2008-Sept	
1		1789
2		1813.73
3		1842.985
4		1872.268
5		1878
	2010 Aug	
1		4
2		5.767857
3		24.11289
4		59.02769
5		61.95238
	2010 Sept	
1		64
2		109.9791
3		168.5102
4		178.0713
5		197.6458
	2010 Oct	
1		200.8929
2		217.9881
3		233.0779
4		311
	2010 Nov	
1		37.26821
2		115.119
3		164.6407
4		192.4073
5		200.2391

2. Model Development

2.1. Auto-Regressive Model:

In a series where persistency is presence, that is the event out come of $(t+1)^{th}$ period is dependent on the present t^{th} period magnitude and those preceding values, then for such a series, the observed sequences $X_1, X_2, \ldots, X_t$ is used to fit the AR model.

$$X_t - \mu = \beta_1 (X_{t-1} - \mu) + \beta_2 (X_{t-2} - \mu) + \ldots\ldots + \beta_K (X_{t-k} - \mu) + \varepsilon_i \ldots\ldots\mathbf{(1)}$$

Where, μ is the mean of the series, ε is the random vitiate with zero mean and variance σ_ε^2. Which is known as k^{th} order AR model.

3. Data Analysis

Table 1: Estimation of statistical parameters

Sl.No	**Discharge M^3/sec**	**$(X_t\text{-}798.2)^2$**	**$(X_t\text{-}798.2)^*$ $(X_{t-1}\text{-}798.2)$**	**$(X_t\text{-}798.2)^*$ $(X_{t-2}\text{-}798.2)$**
1	1667	754813.4	840824.64	904247.04
2	1766	936636.8	1007286.24	1045030.44
3	1839	1083264.6	1123855.84	1423606.24
4	1878	1165968.0	1476950.44	1479110.04
5	2166	1870876.8	1873612.40	1732729.04
6	2168	1876352.0	1735262.60	-1081046.16
7	2065	1604782.2	-999758.6	-964288.16
8	9	622836.6	600739.0	577063.04
9	37	579425.4	556589.4	539081.84
10	67	534653.4	517835.8	440328.64
11	90	501547.2	426478.0	321664.44
12	196	362644.8	273519.2	201857.44
13	344	206297.6	152247.8	105919.44
14	463	112359.0	78168.6	56380.64
15	565	54382.2	39224.2	33394.24
16	630	28291.2	24086.2	24086.24
17	655	20506.2	20506.2	20506.24
18	655	20506.2	20506.2	20506.24
19	655	20506.2	20506.2	17642.24
20	655	20506.2	20506.2	-2835.36
21	675	15178.2	17642.2	-16360.96
22	818	392.0	-2439.4	-15190.56
23	931	17635.8	2629.4	-86877.76
24	31	588595.8	-101884.2	427483.84
25	144	427977.6	501902.2	429286.04
26	241	310471.8	364520.2	-
27	142	430598.4	365634.2	-
Total	**21552**	**30145520.24**	**1093644.96**	**7633324.28**

The first order AR model is represented as

$$X_t - \mu = \beta_1 (X_{t-1} - \mu) + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(2)}$$

and is found to be very useful in water resource engineering.

2.2. Moving Average model:
The equation for moving model for generating the values X_t at any instant t in the series is as

$$X_t - \mu = \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} + ... + \alpha_k \varepsilon_{t-k} \text{.....................................}\mathbf{(3)}$$

Where k demotes the order of the moving averages, α_1, α_2, …. α_k are the coefficients

2.3. ARIMA model:
An Auto-Regressive-Integrated-Moving-Average (ARIMA) model of level (1,0,1), which is popular used in hydrological system and his better reprenested as ARIMA (1,0,1). The model is expressed as

$$(X_t - \mu) + \beta_1 (X_{t-1} - \mu) = \varepsilon_t + \alpha_1 \varepsilon_{t-1} \text{.................................}\mathbf{(4)}$$

from table 1, mean=1483.9 m^3/sec. r_1=04547

$$r_1 = \frac{10936444.96}{30145520.24} = 0.3628$$

$$\sigma_\varepsilon^2 = \frac{27-1}{27}(1-0.3628^2)\left[\frac{(30145520.24)}{27-3}\right]$$
=1050366.69
σ_ε = 1024.87 m^3/sec.
From equation (2),

X_t=0.36284X_{t-1}+1533.48
then, estimated X_{28}=1584.9976

From equation (3)
Mean = 798.2m^3/sec, r_1=0.3628, r_2=0.2532, β_1=0.3120, β_2=0.1400, σ_ε^2 =29164413.65, σ_ε =5400.41. m^3/sec.
X_t=798.2+0.3120(X_{t-1}-798.2) +0.14(X_{t-2}-798.2) +5400.41
X_{28}=5915.88 m^3/sec.

CONCLUSION

From the results, X_{28} value for AR-1 is more applicable, estimated and compare to X_{28} value of AR-2, and also calculate the mean monthly rain-fall flow. In this study the future mean values predicted based on the previous observed mean values. ARMA is useful to study about the synthetic generation for the wind flow time series data analysis. It is observed that ARIMA approach is more appropriate prediction for the future meteorological parameters compare with the probability MARKOV chain models. These models can be useful in missing observation data sets.

REFERENCES

[1] Castino F., Festa R., Ratto CF, *Journal of wind engineering in Aerodyn*, **1998**; 74 (76); 141-151.
[2] Heiko B, *Ecol Model*, **2000**; 126; 139-54.
[3] Thomas H.A., Fiering,M.P., Mathematical synthesis of steam flow sequences for the analysis of river basins for simulations, Harvard University press; **1962** :459-493
[4] Srikanthan, R., Mc Monan T.A., Stochastic generation of rain-fall and evaporation data. AWRC technical paper No: 84, **1984**, 301
[5] Shamshad A, M.A.Bawada, W.M.A.Wan Hussan, T.A. Mazid, S.A.M.Sanusi., *Energy*; **2005**; 30: 693-708.