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Stochastic time series analysis of hydrology data for water resources

S Sathish and S K Khadar Babu
Department of Mathematics, School of Advanced Sciences, VIT University, Vellore-632014, India

E-mail: khadar.babu36@gmail.com

Abstract. The prediction to current publication of stochastic time series analysis in hydrology and seasonal stage. The different statistical tests for predicting the hydrology time series on Thomas-Fiering model. The hydrology time series of flood flow have accept a great deal of consideration worldwide. The concentration of stochastic process areas of time series analysis method are expanding with develop concerns about seasonal periods and global warming. The recent trend by the researchers for testing seasonal periods in the hydrologic flowseries using stochastic process on Thomas-Fiering model. The present article proposed to predict the seasonal periods in hydrology using Thomas-Fiering model.

1. Introduction

The classical development of stochastic process to predict the seasonal periods in hydrology using Thomas-Fiering Models. Especially for analyzing the hydrologic wide variation in the River flow various month for different years. The time series analysis of the statistical region in hydrology from River flow data, which is wide domain, statistics has significant as a powerful method for analyze hydrology in time series. The contribution to predict the seasonal periods in hydrology River flow data using Thomas-Fiering model. The time series analysis is used for building arithmetical models to computation of statistics from River flow data using Thomas-Fiering model. The contribution of this paper to predict the seasonal periods in hydrologic flow series of stochastic process using Thomas-Fiering model.

2.Review of literature

The arithmetical model to expand synthetic hydrology records developing in time series analyze, to forecast hydrology events notice in the missing data and continue records. The current trend time series is homogeneous, fixed. Otherwise non-periodic is without continuation Adeloye and Montaseri, [2].

A time series definitely have fixed data when its statistical properties do not different variation of time origin. The first and second order moments depends only on time variation(Chen and Rao, [2].The normally time series is fixed data stationary does not exit. The second order stationary is essentially occur as fixed time series.

The earth's rotation around the sun. Which is astronomical cycles due to period is normally time series Kite. To identify and quantify the periodicity in the hydrology or climatology time series, the time scale is to be considered less than a year (e.g., month or six months). In the hydrologic time series analysis, multiple comparison tests are still contemporary, while these tests are considered classical in the geotechnical field e.g., Phoon et al [3]. Climate change "is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (IPCC, Intergovernmental Panel on Climate Change. Higher temperatures could potentially increase evaporation rates at surfaces and transpiration by plants, which leads to a reduction in runoff Frederick and Major[5]. The environment change will accelerate the hydrology cycle with an increasing intensity of rainfalls and occurrence of maximum weather events Milly et al [8]. The consequences of this modification are manifold. The nearly 2.4 billion people lived in water stressed river basins and this number is supposed to rise in the futureArnell et al [7].

Despite the various impacts on river flow, today only a tiny number of rivers are protected by any sort of environmental flow management Richter et al. and according to current trends in riverine species loss, global warming, population develop and land-use change, freshwater ecosystems will remain threatened well into the future Vor¨osmarty et al [6]. In order to assess changes in river flow regimes, we applied a methodology by Laize et al. [13].which is based on the Range of Variability Approach (RVA).

3 Method and Discussion

Applications

A linear auto regressive scheme which is probability of being a particular state in a given period is dependent on the actual state in the preceding time period. Which scheme are stochastic process.

$$x_i - \mu = \alpha_1 (x_t - \mu) + V_t$$

In which X_t is the dependent stationary stochastic series, μ the mean, α_1 the auto regressive coefficient V_t is the independent stationary stochastic component.

Thomas-Fiering(1962) in above markov chain model from taken producing monthly flow rivers data into consideration one serial correlation level. This model is widely used to generate flow series for monthly or seasonal periods. In the concept always assume that the July flows are always dependent on June values.

$$Q_p j + 1 = Q_{av} j + 1 + b_j (Q_{pj} - Q_{av+j}) + t_p S_{j+1} \sqrt{1 - r^2}$$

Where Q_{j+1} and Q_j are the advantage volumes during $(\mathrm{j}+1)^{th}$ and j^{th} months respectively, $Q_{av} j + 1$ and Q_{avj} the mean monthly discharge volumes during $(\mathrm{j}+1)^{th}$ and j^{th} months, respectively, S_{j+1} and S_j standard deviations for $(\mathrm{j}+1)^{th}$ and j^{th} months respectively, r_j correlation between the j^{th} and $(\mathrm{j}+1)^{th}$ months, t_p the random separately variate with zero mean and one variance, P the year, j the month, i.e., $j = 1$ stands for January and so on.

Time Series on T-F Model:

A time series is a sequence of Measurements of the same variables made over time. Usually the measurements are made at evently spaced times.

Monthly (or) yearly which is the problem in y-variable measures as a time series.

Here $'y'$ as global temperature, with measurements observed each years. Estimate that the values over time, $'t'$ subscript rather than $'i'$ i.e. y_t means y measured in time period t .

An auto regressive model is when value from a time series is regressed on previous values from that same time series.
First order stationary Markov model are known as Thomas Fiering model (Stationary)

$$X_{j+1} = \mu_X + \rho_1(X_j - \mu_X) + t_{j+1}\sigma_X\sqrt{1-\rho_1^2}$$

Stationary with respect to mean, variance and lag-one correlation
Known sample estimates of μ_X , σ_X , ρ_1 and Assume $X_1(=\mu_X)$
Generate value $X_1, X_2, X_3, \ldots$
First order Markov model with non-stationary, for stream flow generation.

$$X_{i,j+1} = \mu_{j+1} + \rho_j\sigma_{j+1}/\sigma_j(X_{ij} - \mu_j) + t_{i,j+1}\sigma_{j+1}\sqrt{1-\rho_1^2}$$

ρ_j Which is one serial correlation among flows in j^{th} month and $(j+1)^{th}$ month $t_{i,j+1} \sim N(0,1)$

4 Area and population of river basins in India
Table 1. River Basins in India

River Basins	Catchment	Length of River		Population
Area	Total (KM)	Density		%
All Basins	Km2 3,191	Million 932 888	NO/km2 282 301	 24 73
Basins of the Westerly flowing Rivers	Indus 321 Narmada 99 Sabarmati 22	48.8 17.9 6.0	140 160 521	71 79 54
Basins of the Easterly flowing Rivers	Cauvery 81 Ganga 861 Godavari 313 Krishna 259	32.6 370.2 76.7 68.9	389 449 186 253	70 60 85 68

From the river basins In India we get total percentage $\frac{487}{7}$ =69.5% .The flood flow of river monthly 7 years available data given here.

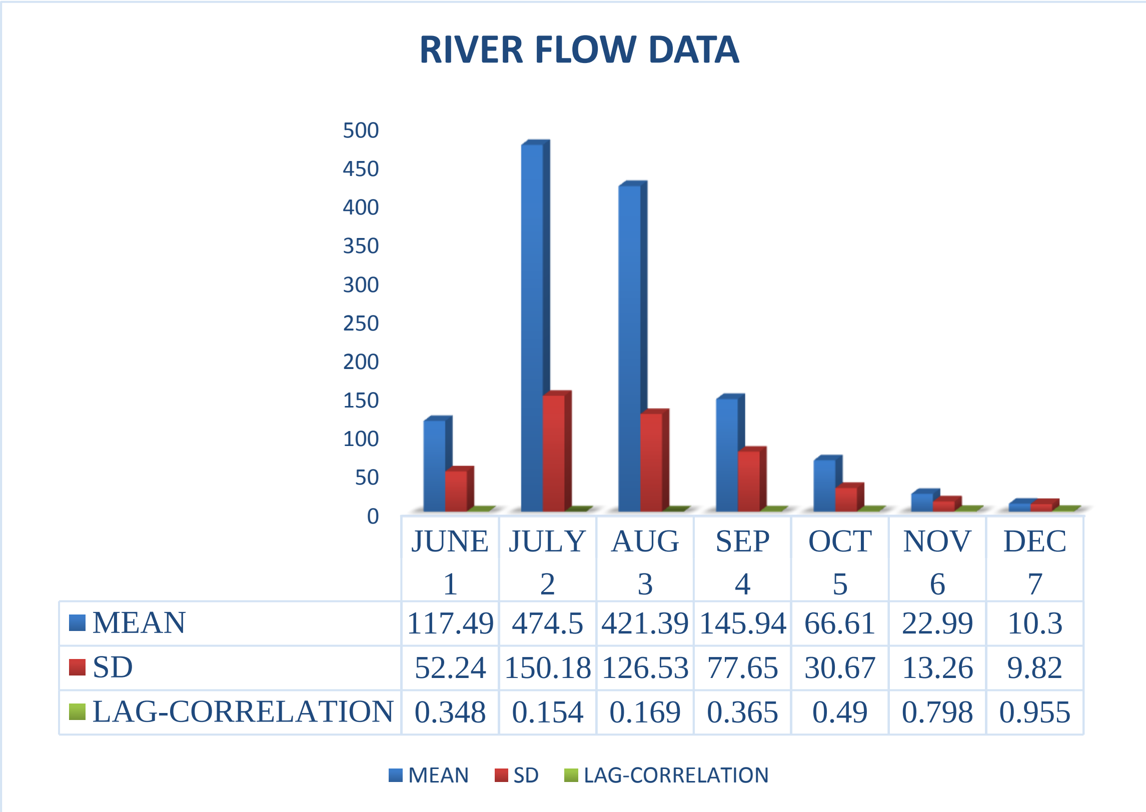
Table 2. Year data

Sl. No.	YEAR	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1979-80	54.60	325.40	509.50	99.40	53.50	25.80	12.50
2	1980-81	220.78	629.16	591.32	120.33	43.33	14.83	8.41
3	1981-82	131.30	538.89	574.21	151.06	53.03	19.49	8.38
4	1982-83	100.19	630.02	702.07	83.29	32.45	16.60	6.80
5	1983-84	171.30	444.30	512.30	211.00	62.40	24.00	8.40
6	1984-85	147.80	636.20	293.50	127.70	79.70	22.10	10.10

Year data (JUN from DEC 7 Month)

Table 3. Standard deviation and Log-one correlation

Sl.No	Month	Mean	Standard Deviation	Log-one Correlation
1	JUN	107.45	62.20	0.458
2	JUL	476.5	145.7	0.154
3	AUG	325.39	126.53	0.169
4	SEP	245.94	77.65	0.365
5	OCT	76.61	30.67	0.490
6	NOV	32.99	13.26	0.798
7	DEC	12.30	9.82	0.955



	JUNE 1	JULY 2	AUG 3	SEP 4	OCT 5	NOV 6	DEC 7
MEAN	117.49	474.5	421.39	145.94	66.61	22.99	10.3
SD	52.24	150.18	126.53	77.65	30.67	13.26	9.82
LAG-CORRELATION	0.348	0.154	0.169	0.365	0.49	0.798	0.955

Figure 1.

Example

$$X_{1,1} = \mu_1 = 107.45$$
$$\sigma_1 = 62.20 \qquad \rho_1 = 0.458$$
$$\mu_2 = 476.5 \qquad \sigma_2 = 145.7$$

$$X_{1,2} = \mu_2 + \rho_1 \frac{\sigma_2}{\sigma_1}(X_{1,1} - \mu_1) + t_{1,2}\sigma_2\sqrt{1-\rho_1^2}$$
$$= 476.5 + 0.458\frac{145.7}{62.20}(107.45 - 107.45) + 175.85 * 145.7\sqrt{1-0.458^2}$$
$$= 23252.64$$

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5. Conclusion

The current trend in stochastic process in time series analyze has been applied in various field Such as hydrology, climatology, seismology. Based on Thomas-Fiering model which is stream flow of river flow data are the main hydrology resources followed by temperature and surface area water quantity, water resources development, which is significant the consideration of worldwide researchers for application in time series analysis of stochastic process in various techniques using Thomas-Fiering model. The performance of the seasonal periods in hydrology using Thomas-Fiering model have major focus of applied research field.

References

[1] Adamowski K and Bougadis J *Hydrological ProcessesJ* **17**(18) 3547 -3560
[2] Adeloye A J and Montaseri M2002*Hydrological Sciences J***47**(5) 679 - 692
[3] Alemaw B F and Chaoka T R 2002*African J. of Science and Technology, Science and Engineering Series***3**9(10) 69-78
[4] Alexandersson 1986*A homogeneity test applied to precipitation data*. J **6**(2) 661 - 675
[5] Beighley E and Moglen G E 2002*Trend assessment in rainfall-runoff behavior in urbanizing* watersheds. J **7**(1) 27 - 34
[6] Brunetti M,Buffoni L,Maugeri M and Nanni T 2000*Precipitation intensity trends in northern ItalyInternational* J **2**(9) 1017 - 1031
[7] Chang T J 1988*Stochastic forecast of water losses*. J **114**(3) 547 - 558
[8] Chen H L and Rao A R 2002*testing hydrologic time series for stationarity*. J **7**(2) 129 -136
[9] Dahmen E R and Hall M J 1990*screening of hydrologic data J***49** (60)
[10] Darken P F, Holtzman G I,Smith E P and Zipper C E 2000*Detecting changes in trends in water quality using modified Kendall's tau*. *J***11**(4)423 - 434
[11] El-shaarawi A H,Esterby S R and Kuntz K W 1983*A statistical evaluation of trends in the water quality of the Niagara River*. *J* **9**(3) 234 - 240
[12] Esterby S R 1996*Review of methods for the detection and estimation of trends with emphasis on water quality applications. J* **10**(2) 127 - 149
[13] Katsano K and Lambrakis N 2015 *describing the karst evolution by the exploitation of Hydrologic Time-series data. J* **29**(9) 3131 - 3147
[14] William H and Farmer Richard M 2016 *on the deterministic and stochastic use of hydrologic models. J* **52**(7) 5619 - 5633