Research On Stochastic Forecasting Discharge Level Time Series Data Using Extended Linear Group And Extended Semi-Group Approach

S Sathish, SK Khadar Babu

Abstract : The water is an important component for human beings, animals, autotrophs and heterotrophs. Actually, human beings continuously adopted to their physical environment. Due to the increased population, human needs more water for drinking, agriculture, etc. The proposed paper explained in detail, the standard measures like mean, standard deviation, co-efficient of R2 and auto-correlations of the downscaling data in hydrology. The new model is MLE by Gaussian distribution is a method that we will find the values of that result are best fit the data sets. Simple downscaling approach, in general, can perform well as the parametric method, generate the observed water level using SELGA and SELSGA approaches. Maximum Likelihood Estimation is the best prediction using parameters of water level data sets. The new model is used, the present proposed article is to predict future values using stochastic extended linear group average and stochastic extended linear semi-group average on generated downscaling data sets.

Index Terms: Stochastic process, Seasonal periods, Moving average, stochastic extended linear group average, stochastic extended linear semi-group average, Maximum likelihood estimation.

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1 INTRODUCTION

The stochastic forecasting and prediction Models are used to generate downscaling data sets on specified water gauging sites. The observed values of water levels and discharge data sets are collected from the different places in different periods. The generated downscaling data gave results on analysis of hydrological evidence to benefit at upcoming period with respect to water level, overflow protection, water power on hydrology measuring method. The application of stochastic process, which is trend on hydrology, management science, seasonal periods and climate change can be predicted stochastic development in MLE. Which is useful in real life. Downscaling is the general term, which is used as a procedure to take information of large scales and make predictors at local scales. The two main approaches to the downscaling climate information are dynamical and statistical. We estimate two stochastic group average for downscaling fit a straight line linear trend discharge level forecasts, a parametric group are (SELGA) and (SELSGA). Recently, they were applied to estimate impacts of forecasts on discharge by used to parameterize the stochastic weather model for downscaling discharge level moving average distribution of a given seasonal climate forecasts discharge in the figure by the downscaling methods, our estimation in the locations of contrasting climate conditions at matralayam. the present paper is used to simulate the large scale downscaling data taken from the water levels and discharge at matralayam gauging site and predict the discharge data for future values. Regarding the use of time series modelling and forecasting hydrological parameters such as rainfall flow/wind flow, multiple researchers have been conducted. By the previous literature, scholars built models and then simulate these parameters for analyzing the variations of climatic parameters.

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2 REVIEWS

Adib and Majd, [1] Studied on the characteristics of parameters of the stochastic variables, the Markovian model make the advantages of correlation between data and can concentrate the characteristics of stochastic parameters. Discharges of arrival flows were produced by markov chain method on research. Ayob and Amat, [2] Analysed the Water Use Trend at Universiti Tekologi Malaysia. An Introduction to Forecasting with Time Series Models (Bell, W. R, [4] Applied and Bowerman, B. L., and O'Connell. R. T, [5] identified the Forecasting and Time Series. Hansen, T.W., Mason, S.J., Sun, L., Tall, A. C.Lee, C.Ko, [7] Considered the use of a lifting scheme and autoregressive integrated moving average (ARIMA) models, seasonal climate forecasting for agriculture, Lifting scheme enhance the forecasting accuracy embedded through ARIMA models. G.Naadimuthu, E.S.Lee [8] proposed the simultaneous optimization of the initial design and operating policy over the life of multipurpose multireservoir water resources systems receiving stochastic inflows. This approach basically depended on the division of the reservoir into two imaginary water storage pools, the conservation and flood pools. Ahmadi, Doostparast et al., 2013 point out the Estimating the lifetime performance index with Weibull distribution based on progressive first-failure censoring scheme, Studied about the Failure-censored reliability sampling plans for the exponential distribution. Sathish and Khadar Babu, [9] predicted the about stochastic prediction models for food grains time series data. Identified 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) and Vittal, P.R., Thangaraj, V., Muralidhar, V. R.S.Wilby, S.L.Charles, et al., [6] and [10-11], Based on particular slight differences between the coarse GCMs and fine observed data. Statistical downscaling is a straightforward methodology obtaining high resolution climate projections, stochastic models for the amount of overflow in a finite dam with random inputs. Wilby, R. L., Hassan, H., Hanaki, K, et al., [12] Features of the Prediction the Statistical downscaling of hydro meteorological variables using general circulation model output. Wetterhall, F., Winsemius, H., Dutra, E., Werner, M., Paper Berger, E. Seasonal predictions of agro-metrological drought indicators for the Limpopo basin. Hydrol. Earth

Syst.Sci, [13] observed data to calibrate and validate the statistical model(s) and GCM data for future climate to drive the model(s). Reviews of downscaling methods are widely available. The combined dynamical-statistical downscaling approaches lessons from a case study on the Mediterranean region. Hydrology and Earth System Sciences by Guyennon, N., Romano, E., Portoghese, I., Salerno, F., Calmanti, S., Perangeli, A.B., Tartari, G., & Copetti, D, and Andreas Behr and Sebastian Tente, et al., [3] analyzed are maximum likelihood and the method of moments. Symphonious structures, lessening overwhelming, while to date addressing the impact of various insights by Walsh and Wheeler [14].

3 STUDY AREA DESCRIPTION

Specifications of Data used and Geographical location of the studied region The region taken up of study is located at Matralayam in Andhra Pradesh on Tungabhadra and Krishna River covering the area between a villages of AP and Telangana. The area is identified by the map. Mantralayam is a temple city of Andhra Pradesh at a distance of 74 km from Kurnool, 148 km from Nandyal and 253 km from Hyderabad. In Andhra Pradesh, during heavy rains approximately 11 tmc ft of water are unutilized flowing into the bay of Bengal from prakasm barrage. Storage and prediction of water level for future generated in the context of increasing demand for water is matter of great importance. Forecast of the water discharge level of the existing and the newly coming up barrages have been taken up for study in the seasonal work.

2 PROCEDURE FOR PAPER SUBMISSION

2.1 Review Stage

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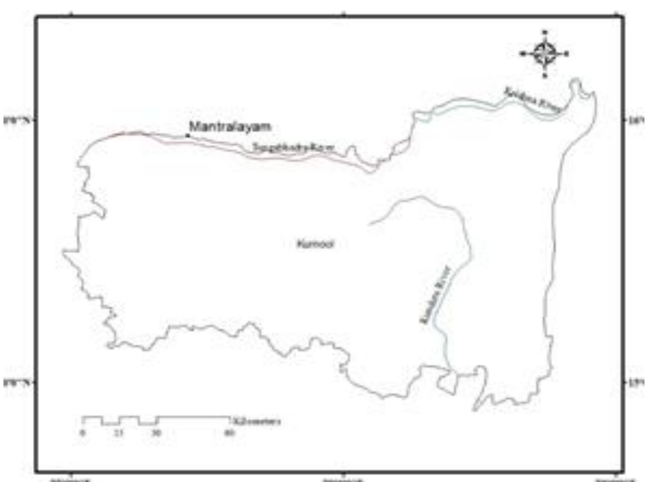

Fig. 1. Location of the studied Region at AP

Downscaling data sets on 2000 $\left(\mathrm{m}^3/\mathrm{s}\right)$, for the data, observed values are in the Table I and Table II

TABLE I *Downscaling data -2000 (Jan– Per day)*

Per day	Discharge (m^3/s) Water level-s_t	Per day	Discharge(m^3/s) Water level-s_t
1	38.39	10	46.58
2	48.03	11	44.89
3	53.07	12	45.52
4	66.28	13	40.19
5	73.41	14	42.27
6	68.50	15	33.1
7	55.82	16	37.79
8	56.03	17	34.83
9	45.49	18	29.17

TABLE- II: *DOWNSCALING DATA -2015 (DEC- PER DAY)*

t	St	3 – Point moving total	3 – Point moving average-(Mt)	Stochastic extended extendedline ar group average	Stochastic extended extendedline ar semi-group average
1	21.43			20.17	17.80
2	18.28	56.30	18.76	18.62	17.53
3	16.59	48.90	16.30	17.07	17.27
4	14.03	44.18	14.72	15.52	17.01
5	13.56	41.48	13.82	13.97	16.74
6	13.89	44.09	14.69	12.42	16.48
7	16.64	50.97	16.99	18.83	16.22
8	20.44	52.95	17.65	17.62	15.96
9	15.87	51.43	17.14	16.41	15.69
10	15.12	46.65	15.55	15.2	14.68
11	15.66	41.93	13.97	13.99	15.25
12	11.15	38.47	12.82	12.78	15.82
13	11.66	35.19	11.73	12.48	16.39
14	12.38	35.21	11.73	11.84	16.96
15	11.16	34.14	11.38	11.2	17.53
16	10.58	31.84	10.61	10.56	18.11
17	10.09	29.28	9.76	9.92	18.68
18	8.61			9.28	19.25

SELGA = $b' = \frac{y^{(3)}-y^{(1)}}{t_{03}-t_{01}} = \frac{16.29-10.75}{12}$ = 0.46, SELSGA = $b'' = \frac{y^{(2)}-y^{(1)}}{t_2-t_1} = \frac{16.74-11.82}{9}$ = 0.54

The uses of b' and b'' is evenly distributed about zero.

4 DATA AND METHODOLOGY

All possible generated values are shown in Table III
Table III Stochastic extended linear group and stochastic extended linear semi-group average

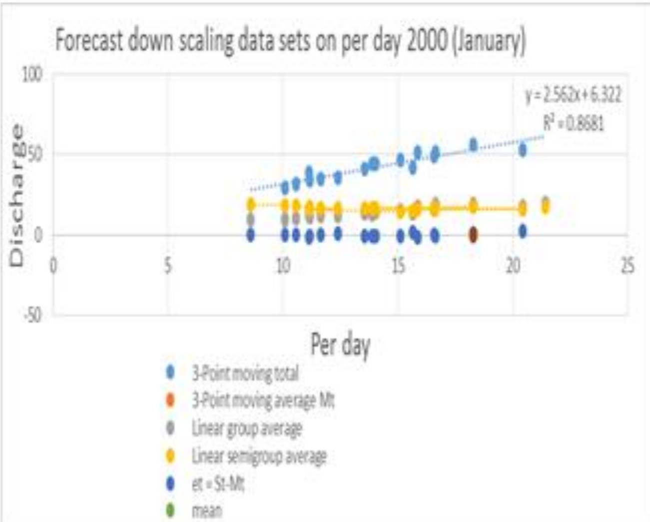

Fig. 2. *Forecast down scaling data sets per day (Jan-2000)*

4.1 Calculate the maximum likelihood estimates of the parameter values of the Gaussian distribution μ and σ

$$P(x;\mu,\sigma)=\sum_{x=1}^{18}\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

(1)

$$P(18\,\text{Perdays};\mu,\sigma)=\sum_{x=1}^{18}\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(0.48-\mu)^2}{2\sigma^2}\right)\times\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(0.29-\mu)^2}{2\sigma^2}\right)\times..$$
$$..\times\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(0.33-\mu)^2}{2\sigma^2}\right)$$

(2)

Taking logs of the original expression is given us

$$\text{In}(P(x;\mu,\sigma))=\sum_{x=1}^{18}\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(-0.48-\mu)^2}{2\sigma^2}+\text{In}\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(0.29-\mu)^2}{2\sigma^2}+..$$
$$.+\text{In}\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(0.33-\mu)^2}{2\sigma^2}$$

(3)

We can simplify above expression using the laws of logarithms to obtain

$$\text{In}(P(x;\mu,\sigma))=-18\text{In}(\sigma)-\frac{18}{2}\text{In}(2\pi)-\frac{1}{2\sigma^2}\left[(-0.48-\mu)^2+(0.29-\mu)^2+...+(0.33-\mu)^2\right]$$

(4)

This expression can be differentiated to find the maximum. We can find the MLE of the mean μ To do this we take the partial derivative of the function with respect to μ , giving

$$\frac{\partial\text{In}(P(x;\mu,\sigma))}{\partial\mu}=\frac{1}{\sigma^2}(-0.48+0.29+..+0.33\mu) \quad (5)$$

Finally, setting the left hand side of the equation to zero and rearranging for μ gives

$$\mu=\frac{-0.48+0.29+...+0.33}{18}=-0.03$$

Similarly we have to get σ

$$\frac{\partial\text{In}(P(x;\mu,\sigma))}{2\sigma}=\frac{1}{2\sigma}[-0.48+0.29+..+0.33-\mu] \quad (3.1.6)$$

$$2\sigma=[-0.48+0.29+...+0.33-\text{Fitted value}(0.03)]$$

$$\mu=-0.03\,,\,\sigma=-0.04$$

Moving average: Mean = -0.03 , Standard deviation = 1.07
Maximum likelihood estimation: Mean = -0.03 , Standard deviation = -0.04

Residual value t = 1, et = 1.54, Mean ($\bar{e}$) = 0.324375 and standard deviation (S_e) = 2.911350 The residuals appear to be evenly distributed about Zero. Also there is no long sequence of positive or negative values. The value of $\sqrt{n}\frac{\bar{e}}{S_e}$ = 0.44566. Which model is a good fit for the data.

Table IV *Generated for years 2000 and 2015 at Mantralayam location in AP*

Years : 2010 to 2011 and 2015 to 2016 Location: Mantralayam State: Andrapradesh	*TSS*	*SSE*	R^2
Data-1 Year-2010 to 2011	*417472*	*SLGA-SSE(1) = 185986 SLSGA-SSE(2) = 433224*	R_1^2 = *0.9995* R_2^2 = *0.9989*
Data-2 Year-2015 to 2016	*231073*	*SLGA-SSE(1) = 325585 SLSGA-SSE(2) = 4795.56*	R_1^2 = *0.9859* R_2^2 = *0.9997*

Comparison of past and current observed Discharge level of downscaled daily precipitation generated for years 2000 and 2015 at Mantralayam location in AP

Table V *Comparison of past and current observed discharge level of downscaled daily precipitation generated for years 2010 to 2011 and 2015 to 2016 (100 Perdays) at Mantralayam location in AP*

Years : 2000 and 2015 Location: Mantralayam State : Andrapradesh	*TSS*	*SSE*	R^2
Data-1 Year-2000	*58980.97*	*SLGA-SSE(1) = 0.547 SLSGA-SSE(2) = 2137.2*	R_1^2 *= 0.999* R_2^2 *= 0.9637*
Data-2 Year-2015	*658727.02*	*SLGA-SSE(1) = 686.44 SLSGA-SSE(2) = 5628.04*	R_1^2 = *0.9989* R_2^2 = *0.9914*

With respect to the coefficient of determination, $R_1^2 = R_2^2$ =0.999 it is nearly equal to 1.0, it note that if the fit is perfect, all residuals are zero. But if SSE is only slightly smaller than SST. The coefficient of determination suggests that the model fit to the data explains 99.9% of the variability observed in the response.
The location of the studied region at Andhra Pradesh is shown in Fig.1. It is clear that the details of covered the area between the villages of Andhra Pradesh and Telangana which shown the area is identified by using the map. Mantralayam is a temple city of Andhra Pradesh at a distance of 74 km from Kurnool, 148 km from Nandyal and 253 km from Hyderabad. We forecasted down scaling data sets shown in Fig.2. Which is showed that the data is generated water level monthly perdays data sets. Comparison of past and current observed discharge level of downscaled daily precipitation generated measures for the years 2000 to 2015 (18/days), 2010 to 2015, 2015 to 2016 (1 year) at Mantralayam location in AP shown in Table IV and Table V. This study fulfilled the objectives of the study to propose the riverflow forecasting methods using SELGA, SELSGA and Measure of quality of fit, maximum likelihood estimation method and then inspect the accuracy of models in forecasting ability. Stochastic prediction has its own advantage in forecasting ability, especially for downscaling process in water resource engineering.

5.2 Stochastic forecasting estimation process

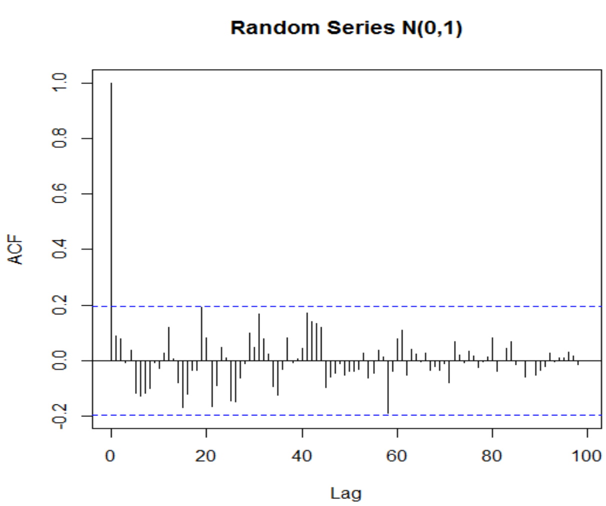

Fig. 3. *Discharge level-2015 to 2016 (NOV to FEB –100 Per days)*

6 CONCLUSION

Two stochastic group averages downscaling methods are developed and analyzed utilizing in this study discharge data from weather climate locations at mantralayam. A generated downscaling methods, in general, can prediction process well as the parametric method, generate using SELGA and SELSGA approaches. Therefore, the mentioned method can be used for being aware of the discharge levels and the probability of occurrence of the flow in future years. Finally we conclude that the new procedure is comparatively approachable by past year 2000, 2010 to 2011 and present year 2015 to 2016 on generated downscaling data sets are specified stochastic moving group average methods and Maximum likelihood estimation. In advantage of using R code we can estimate discharge level of random series N (0, 1). It would be good practice to obtain a better set of measurements and combine two years water level discharge 38 days and 1 year and, so on daily data sets of information in order to compare and especially improve the future estimation method.

7 REFERENCES

[1] Adib, A.R.M, Majd, “Optimization of Reservoir Volume by Yield Model And Simulation of it by Dynamic Programming and Markov Chain Method”. American-Eurasion J.Agric. & Environ. Sci., 2009, vol. 5, no. 6, pp. 796-803.

[2] K. Ayob, S.D, Amat ,” Water Use Trend at Universiti Tekologi Malaysia”: Application Of Arima Model. Jurnal Teknology, 2004, vol. 41, n0. 1, pp. 47-56.

[3] Andreas Behr and Sebastian Tente -Stochastic frontier analysis and means of maximum Likelihood and the method of moments, 2008, vol. 978-3-319-20502-18.

[4] W.R Bell, “An Introduction to Forecasting with Time Series Models”. Insurance Mathematics and Economics 3, 1984, pp. 241-255.

[5] B.L ,Bowerman, R.T, O’Connell, “Forecasting and Time Series”: An Applied Approach, 1993, Third Edition. Duxbury Press.

[6] T.W, Hansen, S.J, Mason, L, Sun, A, Tall, “ Review at seasonal climate forecasting for agriculture in Sub-Saharan” Africa.Exp.Agric, 2011, vol.47, no.2, pp. 205.

[7] C. Lee, C, Ko,” Short-term Load Forecasting Using Lifting Scheme and ARIMA Models”. Expert Systems with Applications, 2011, Vol. 38, pp. 5902-591.

[8] G, Naadimuthu, E.S. Lee, “Stochastic Modelling and Optimization of Water Resources Systems”, Mathematical Modelling, 1982, Vol. 3, pp. 117-136.

[9] S, Sathish, SK. Khadar Babu, “Stochastic time series analysis of hydrology data for water resources”. J.Iop Anal.Appl, 2017, vol. 263, 042140.

[10] P.R. Vittal, V.Thangaraj and V.Muralidhar, “Stochastic models for the amount of overflow In a finite dam with random inputs, random outputs and Exponential release policy”, Stochastic analysis and Applications, 2011, vol. 29, pp. 473-485.

[11] R.L, Wilby, S.P, Charles, E, Zorita, B, Timbal, P, Whetton, L, Mearns, “Guidelines for Use of Climate Scenarios Developed from StatisticalDownscaling Methods”. IPCC Task Group on Data and ScenarioSupport for Impact and Climate Analysis, 2004.

[12] R.L, Wilby, H, Hassan, K, Hanaki, “Statistical downscaling of hydrometeorological variables using general circulation model output”, J. Hydrol.,1998, vol. 205,pp.1–19.

[13] F, Wetterhall, H, Winsemius, E, Dutra, M, Werner, E, Paper Berger, “Seasonal predictions of agro-metrological drought indicators for theLimpopo basin”, Hydrol. Earth Syst. Sci, 2015, vol.19, no.6, pp. 2577-258.

[14] Walsh P, Wheeler W (2012) Water uncommon document vital andmoney sparing addition examination. U.S. natural fitness association, taking strolls Paper, 12-05.
[15] Walski TM, Parker FL (1974) patron's water super report. J Environ Eng ASCE a hundred:593–sixty one.