International Journal of Scientific Research in Multidisciplinary Studies
Vol.6, Issue.11, pp.24-28, November (2020)
Research Paper
E-ISSN: 2454-9312
P-ISSN: 2454-6143

Forecasting Discharge Level time Series on Statistical Parametric Approach using Hydrological Data

S. Sathish [1*], S.K. Khadar Babu[2]

[1]Dept. of Mathematics, Bioinformatics and Computer Application, MANIT, Bhopal, Madhya Pradesh, India
[2]Dept. of Mathematics, VIT Vellore, SAS, Vellore, Tamil Nadu, India

[*]*Corresponding Author: subramanisathish88@gmail.com*

Available online at: www.isroset.org

Received: 10/Nov/2020, Accepted: 20/Nov/2020, Online: 30/Nov/2020

Abstract**—**At present, water is a critical part for people, animals, autotrophs and heterotrophs. In actuality, people continually grasped to their state of being. Due to the extended people, human requirements more water for drinking, farming, and so on. The proposed paper explained in detail, the standard measures like mean, standard deviation, co-efficient of R^2 and auto-correlations of the downscaling data in hydrology. The new model is MLE by Gaussian dispersion is a strategy that we will discover the estimations of that outcome are best fit the informational collections. Straightforward downscaling approach, when all is said in done, can perform well as the parametric technique, produce the noticed water level utilizing SELGA and SELSGA approaches. Maximum Likelihood Estimation is the best forecast utilizing boundaries of water level informational collections. The new model is utilized, the present proposed article is to foresee future qualities utilizing stochastic extended straight gathering normal and stochastic expanded direct semi-bunch normal on produced downscaling informational indexes.

Keywords— Stochastic process, Seasonal periods, Moving average, stochastic extended linear group average, stochastic extended linear semi-group average, Maximum likelihood estimation**.**

I. INTRODUCTION

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 utilization of stochastic cycle, which is pattern on hydrology, the board science, occasional periods and environmental change can be anticipated stochastic improvement in MLE. Which is helpful, all things considered. Downscaling is the overall term, which is utilized as a system to take data of enormous scopes and make indicators at nearby scales. The two fundamental ways to deal with the downscaling atmosphere data are dynamical and factual. 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. 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] Analyse the Water Use Trend at Universiti Tekologi Malaysia.

An Introduction to Forecasting with Time Series Models (Bell, W. R, [5] Applied and Bowerman, B. L., and O'Connell. R. T, [6] identified the Forecasting and Time Series. Hansen, T.W., Mason, S.J., Sun, L., Tall, A. C.Lee, C.Ko, [8,9] Consider 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 [10] 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. M.A. Thyer and G. Kuczera [16] Measured of long-term dependence in stochastic models of hydrological series. For the case study presented probability than the widely used log-one autoregressive (AR (1)) model of run-lengths larger than 30 years Singh et al., [14] Analyzed the assessing Potential for Rooftop Rainwater harvesting", An Option for Sustainable Rural Domestic Water Supply in

Arid Region of Haryana. Researched on extraction of agricultural phenological parameters of Sri Lanka using MODIS, NDVI time series data and mentioned the following rainfall events by Jayawardhana and Shellito [13]. Sathish and Khadar Babu [11] Studied about the stochastic prediction models for food grains time series data. Thyer and Kuczera [15] developed hidden state Markov model for hydro- climatic time series data analysis.

II. RELATED WORK

Ahmadi, Doostparast et al., [4] point out the Estimating the lifetime performance index with Weibull distribution based on progressive first-failure censoring scheme. Balasooriya, [7] Studied about the Failure-censored reliability sampling plans for the exponential distribution. Sathish and Khadar Babu, [12] predicted the about stochastic prediction models for water resources time series data. Recognized and evaluate the periodicity in the hydrology or climatology time arrangement, the time scale is to be viewed as not exactly a year (e.g., month or a half year) and Vittal, P.R., Thangaraj, V., Muralidhar, V. R.S.Wilby, S.L.Charles, et al., [17] and [18], 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., [19] Features of the Prediction the Statistical downscaling of hydro meteorological factors utilizing general flow model yield. Wetterhall, F., Winsemius, H., Dutra, E., Werner, M., Paper Berger, E. Occasional forecasts of agro-metrological dry season markers for the Limpopo bowl. Hydrol. Earth Syst.Sci, [20] 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.

III. STUDY AREA

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 a ways off of 74 km from Kurnool, 148 km from Nandyal and 253 km from Hyderabad. In Andhra Pradesh, during weighty rains around 11 tmc ft of water are unutilized streaming into the sound of Bengal from prakasm blast. Capacity and expectation of water level for future produced with regards to expanding interest for water is matter vital. 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.

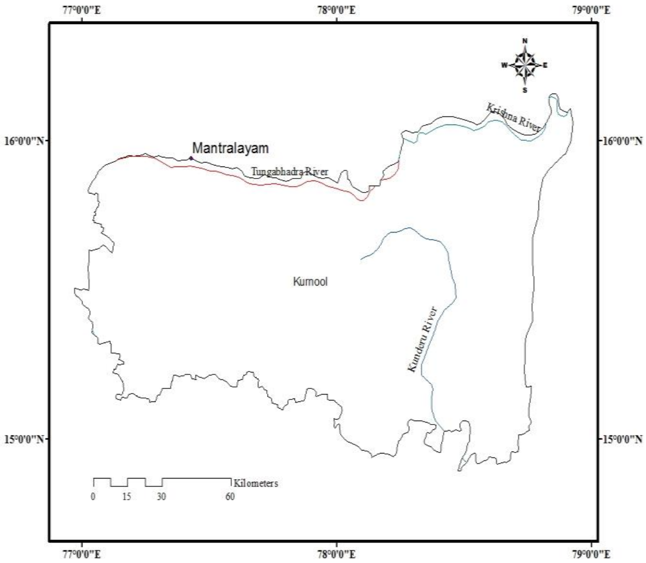

Figure 1. Location of the studied Region at AP

Downscaling data sets $\left(\frac{m^3}{s}\right)$, for the data, observed

Table 1. Downscaling Data -2015 (Dec- Per day)

Per day	***Discharge (m3/s) Water level-s_t***	***Per day***	***Discharge(m3/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

SELGA = $b' = \frac{\bar{y}^{(3)} - \bar{y}^{(1)}}{t_{03} - t_{01}} = \frac{36.22 - 57.94}{12} = -1.81$, SELSGA = $b'' = \frac{\bar{y}^{(2)} - \bar{y}^{(1)}}{t_2 - t_1} = \frac{56.11 - 39.37}{9} = 1.86$

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

All possible generated values are shown in Table 2.

IV. METHODOLOGY

Relevant details should be given including experimental design and the technique (s) used along with appropriate statistical methods used clearly along with the year of experimentation (field and laboratory).

V. RESULTS AND DISCUSSION

Table 2. Stochastic extended linear group and stochastic extended linear semi-group Average-Dec (2015)

t	*St*	*3 – Point moving total*	*3 – Point moving average-(Mt)*	*Stochastic extended linear group average*	*Stochastic extended linear semi-group average*
1	38.39			47.96	76.22
2	48.03	139.49	46.49	47.94	73.36
3	53.07	167.38	55.79	47.92	20.5
4	66.28	192.76	64.25	47.9	67.64
5	73.41	208.19	69.39	47.88	64.78
6	68.50	197.73	65.91	47.86	61.92
7	55.82	180.35	60.11	47.84	59.06
8	56.03	157.29	52.43	47.82	56.2
9	45.49	148.05	49.35	47.8	53.34
10	46.58	136.91	45.63	47.78	50.48
11	44.89	136.99	45.66	47.76	47.62
12	45.52	130.6	43.53	47.74	44.76
13	40.19	127.98	42.66	47.72	41.9
14	42.27	115.56	38.52	47.7	39.04
15	33.1	113.16	37.72	47.68	36.18
16	37.79	105.72	35.24	47.66	33.32
17	34.83	101.79	33.93	34.38	30.46
18	29.17			33.82	27.6

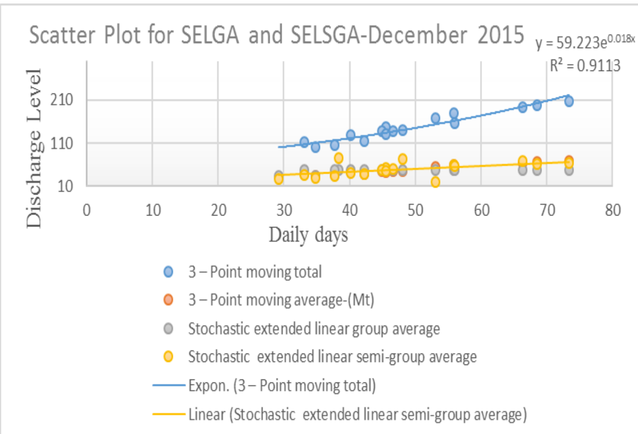

Figure 2. Forecasting Scatter Plot for (Dec-2015)

Relevant details should be given including experimental design and the technique (s) used along with appropriate statistical methods used clearly along with the year of experimentation (field and laboratory). Residual value t = 1, et = -0.48 , Mean ($\bar{e}$) = -0.0325, standard deviation (S_e) = 1.073 . The residuals appear to be evenly distributed about Zero. Also there is no long sequence of positive integer. Maximum likelihood Estimation for discharge data using Gaussian distribution (2000). The generation process can be adequately described by a Gaussian distribution. The Gaussian distribution has two parameters. The mean μ and the standard deviation σ. In 18 per day discharge data points at time and we assume that they have been generated from a process that is adequately described by a Gaussian distribution.

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

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

$$P(18\,\text{Perdays};\mu,\sigma)=\sum_{x=1}^{18}\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(38.39-\mu)^2}{2\sigma^2}\right)\times\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(48.03-\mu)^2}{2\sigma^2}\right)\times..$$
$$..\times\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(29.17-\mu)^2}{2\sigma^2}\right) \quad (2)$$

Taking logs of the original expression is given us

$$\ln(P(x;\mu,\sigma))=\sum_{x=1}^{18}\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(38.39-\mu)^2}{2\sigma^2}+\ln\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(48.03-\mu)^2}{2\sigma^2}+..$$
$$.+\ln\left(\frac{1}{\sigma\sqrt{2\pi}}\right)-\frac{(29.17-\mu)^2}{2\sigma^2} \quad (3)$$

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

$$\ln(P(x;\mu,\sigma))=-18\ln(\sigma)-\frac{18}{2}\ln(2\pi)-\frac{1}{2\sigma^2}\left[(38.39-\mu)^2+(48.03-\mu)^2+...+(29.17-\mu)^2\right] \quad (4)$$

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

$$\frac{\partial\ln(P(x;\mu,\sigma))}{\partial\mu}=\frac{1}{\sigma^2}(38.39+48.03+..+29.17\mu) \quad (5)$$

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

$$\mu=\frac{38.39+48.03+...+29.17}{18}=47.74$$

Similarly we have to get σ

$$\frac{\partial\ln(P(x;\mu,\sigma))}{2\sigma}=\frac{1}{2\sigma}[38.39+48.03+..+29.17-\mu] \quad (6)$$

$\mu = 47.74, \sigma = 405.81$

Moving average: Mean = -0.03 , Standard deviation = 1.07 Maximum likelihood estimation: Mean = 47.74 , Standard deviation = 405.81 From the discharge level data in the year of December 2015 most of values not equal but extended approach is nearly about zero, so our data is fit for the data sets.

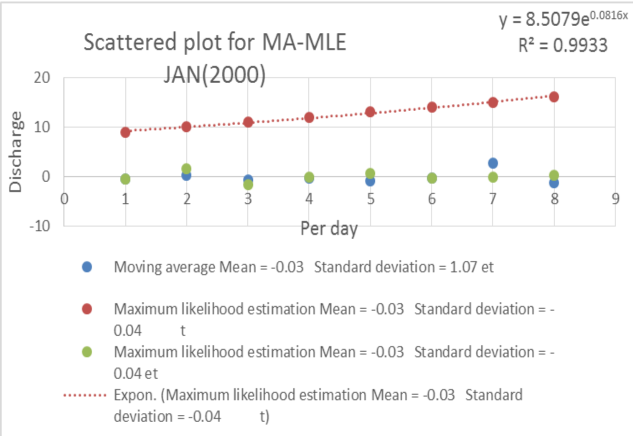

Figure 3. Scattered plot for MA-MLE (Jan-2000)

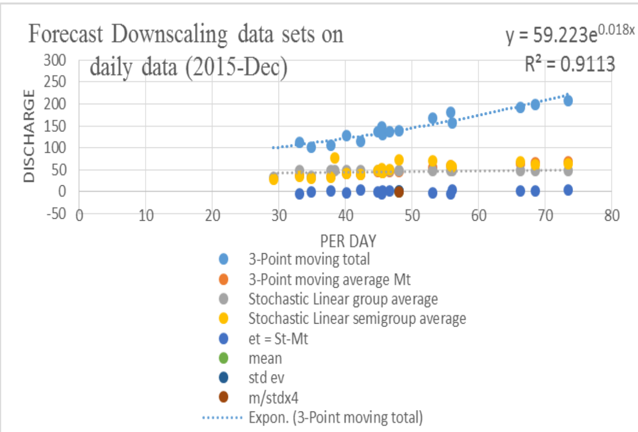

Figure 4. Forecast down scaling data sets per day (Dec-2015)

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.

Estimation for Gaussian distribution (2000-January)

$$P(x;\mu,\sigma) = \sum_{x=1}^{18} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2} \right), \mu = 0.3, \sigma = 2.$$

Moving average: Mean = 0.3, Standard deviation = 2.91

Maximum likelihood estimation: Mean = 0.3, Standard deviation = 2.4

The downscaling data (Discharge level) is shown in Table 1 and SELGA and SELSGA results are shown in Table 2. Past and the current observed discharge level of downscaled daily precipitation generated measures for the years 2000 to 2015 at Mantralayam location in AP is shown in Table 3.

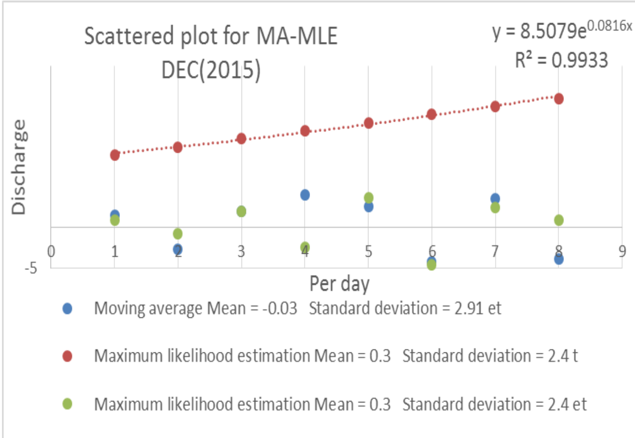

Figure 5. Scattered plot for MA-MLE (Dec-2015)

Measure of quality of Fit

With respect to the coefficient of determination, R Square is 0.999 it is nearly equal to 1.0, it shows 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.

Table3. Generated for years 2000 and 2015 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	$R_1^2 = 0.999$ $R_2^2 = 0.963$
Data-2 Year-2015	658727.02	SLGA-SSE(1) = 686.44 SLSGA-SSE(2) = 5628.04	$R_1^2 = 0.998$ $R_2^2 = 0.991$

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

Further, from the Figure 1 shown Location of Study area . Figure 2 to 3, are the perfect fits for the Forecast and Scatter plot actual values. The significance analyses of water levels and final estimates of the significance parameters by using MA and MLE predicted values are shown in Figures 3 to 5 and the Forecast discharge level estimated values of the best fit in Figure 4.

VI. CONCLUSION AND FUTURE SCOPE

Two stochastic gathering midpoints downscaling strategies are created and investigated using in this examination release information from climate atmosphere areas at mantralayam. A created downscaling strategy, when all is said in done, would prediction be able to process well as the parametric technique, produce utilizing SELGA and SELSGA, Moving Average and Maximum Likelihood Estimation approaches. In this manner, the referenced technique can be utilized for monitoring the release levels and the likelihood of event of the stream in future years. Finally we conclude that the new procedure is comparatively approachable by past year 2000 and present year 2000 to 2015 and so on produced downscaling informational collections are indicated stochastic moving gathering normal techniques and Maximum probability assessment. In preferred position of utilizing R code we can appraise release level of arbitrary arrangement N (0, 1). It would be acceptable practice to acquire a superior arrangement of estimations and consolidate two years water level release 18 days and compare 5 years generated data and, so on daily data sets of information in order to compare and especially improve the future estimation method.

ACKNOWLEDGMENT

The author would like to Thank Vellore Institute of Technology for the support.

REFERENCES

[1] S. Willium, "Classsification of SKC Algo," IEEE Transaction, Vol.**31,** Issue.**4**, pp.**123-141**, **2012**.

[2] A. 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, **Vol. 5, Issue.6, pp.796-803, 2009**.

[3] K. Ayob, S.D. Amat, S. D, "Water Use Trend at Universiti Tekologi Malaysia. Application Of Arima Model," Jurnal Teknology, **Vol. 41 (B), pp. 47-56, 2004**.

[4] Andreas Behr, Sebastian Tente, "Stochastic frontier analysis and means of Maximum Likelihood and the method of moments," **pp. 978-3-319-20502-18, 2008**.

[5] MV. Ahmadi, M. Doostparast, J. Ahmadi, "Estimating the lifetime performance index with Weibull distribution based on progressive first-failure censoring scheme. Journal of Computational and Applied Mathematics" 23, pp. 93–102MathSciNetCrossRefGoogle Scholar, **2013**.

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

[7] B.L. Bowerman, R.T. O'Connell, "Forecasting and Time Series, An Applied Appr"oach," Third Edition. Duxbury Press, **1993**.

[8] U. Balasooriya, "Failure-censored reliability sampling plans for the exponential distribution," J Stat Comput Simul, **Vol. 52, Issue. 4, pp. 337–349, 1995**.

[9] T.W. Hansen, S.J. Mason, L. Sun, A. Tall, "Review at seasonal climate forecasting for agriculture in Sub-Saharan Africa.Exp.Agric," **Vol. 47, Issue. 2, pp. 205, 2011**.

[10] C. Lee, C. Ko, "Short-term Load Forecasting Using Lifting Scheme and ARIMA Models. Expert Systems with Applications," **Vol. 38, pp.5902-5911, 2011**.

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

[12] S. Sathish, SK. Khadar Babu, "Markovian prediction of future values for food," grains in the economic survey. IOP Conf. Series. Materials Science and Engineering, **pp. 263, (042141), 2017**.

[13] S. Sathish, SK. Khadar Babu, "Stochastic time series analysis of hydrology data for water resources," J.Iop Anal.Appl, **pp. 263: 042140, 2017**.

[14] PJ. Shellito, EE. Small, A. Colliander, A, "In situ following rainfall events," Geophys Res Lett 1**, pp. 1−8, 2016**.

[15] Singh, Omvir, Turkiya and Sushila, "Assessing Potential for Rooftop Rainwater Harvesting, An Option for Sustainable Rural Domestic Water Supply in Arid Region of Haryana. Journal Of Rural Development," **Vol. 36, pp. 49-60, 2017**.

[16] M.A. Thyer, G. Kuczera, "Modelling long-term persistence in rainfall time series. Sydney rainfall case study. Hydrology and Water Resources Symposium," **pp.550-555, 1999**.

[17] M.A. Thyer, G. Kuczera, "Modeling long-term persistence in hydro climatic time series using a hidden state Markov Model," Water Resources Research, **Vol. 27, pp. 3301-3310, 2000**.

[18] P.R. Vittal, V. Thangaraj, 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," **Vol. 29, pp. 473-485, 2011**.

[19] R.L. Wilby, S.P. Charles, E. Zorita, B. Timbal, P. Whetton, L.O. Mearns, "Guidelines for Use of Climate Scenarios Developed from Statistical Downscaling Methods. IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis," (TGICA), **2004**.

[20] R.L. Wilby, H. Hassan, K. Hanaki, "Statistical downscaling of hydro meteorological variables using general circulation model output," J. Hydrol, **Vol. 205, pp. 1–19, 1998**.

[21] F. Wetterhall, H. Winsemius, E. Dutra, M. Werner, E. Paper Berger, "Seasonal predictions of agro-metrological drought indicators for the Limpopo basin. Hydrol," Earth Syst. Sci**, Vol. 19, Issue. 6, pp. 2577-2586, 2015**.

AUTHORS PROFILE

Dr. S. Sathish, Ph.D., received his Master of philosophy in mathematics from the Abdul Hakeem College, Arcot, Tamil Nadu, India. He received Master's Degree in Mathematics from University of Madras in Loyola College at Chennai, Tamil Nadu, India. Currently, he is working as a Assistant Professor Department of Mathematics, Bioinformatics and Computer Applications, MANIT Bhopal, Madhya Pradesh, India. He published about 8 research articles in various National and International Journals and presented about 26 articles in National, International conferences/ Seminars/ Workshops He has 7 years of teaching experience Lecturer in the Arts and Science and Polytechnic colleges. His research interests are related to Stochastic Prediction Model and Forecasting Stochastic process using Discharge level data sets, Various data Analysis and Climate Change on Statistical Analysis.

Dr. SK. Khadar Babu, M.Sc., M.Phil., Ph.D is a Associate Professor in Department of Mathematics, School of Advances Sciences, VIT University, Vellore, Tamil Nadu, India. He has 16 years of teaching and research experience. His areas of research are Statistical Quality Control, Statistical Modelling, Time series Analysis, Computer Networks and Digital Image Processing. He is a member in different societies. He published about 85 research articles in various National and International Journals and presented about 122 articles in National, International conferences/ Seminars/ Symposiums/ Workshops. He organized faculty development programme on Probability and Statistics for Engineers. He is the coordinator for VIT Mathematical Meet-2013 conducted by Department of Mathematics, School of Advanced Sciences, VIT, Vellore, Tamil Nadu, India.

