International Journal of Informatics and Communication Technology (IJ-ICT)
Vol. 11, No. 3, December 2022, pp. 185~192
ISSN: 2252-8776, DOI: 10.11591/ijict.v11i3.pp185-192

Statistical analysis of an orographic rainfall for eight north-east region of India with special focus over Sikkim

Pooja Verma[1], Amrita Biswas[1], Swastika Chakraborty[2]
[1]Department of Electronics and Communication Engineering, Sikkim Manipal Institute of Technology, Rangpo, India
[2]Department of Electronics and Communication Engineering, Narula Institute of Technology, Kolkata, India

Article Info

Article history:

Received Mar 1, 2022
Revised Jul 22, 2022
Accepted Aug 8, 2022

Keywords:

ARIMA
Mean square error
Orographic rainfall
Rain-rate
RMSE

ABSTRACT

Autoregressive integrated moving average (ARIMA) models are used to predict the rain rate for orographic rainfall over a long period of time, from 1980 to 2018. As the orographic rainfall may cause landslides and other natural disaster issues. So, this study is very important for the analysis of rainfall prediction. In this research, statistical calculations have been done based on the rainfall data for twelve regions of India (Cherrapunji, Darjeeling, Dawki, Ghum, Itanagar, Kanchenjunga, Mizoram, Nagaland, Pakyong, Saser Kangri, Slot Kangri, and Tripura) from the eight states, i.e., Sikkim, Meghalaya, West Bengal, Ladakh (Union Territory of India), Arunachal Pradesh, Mizoram, Tripura, and Nagaland) with varying altitudes. The model's output is assessed using several error calculations. The model's performance is represented by the fit value, which is reliable for the north-east region of India with increasing altitude. The statistical dependability of the rainfall prediction is shown by the parameters. The lowest value of root mean square error (RMSE) indicates better prediction for orographic rainfall.

Corresponding Author:

Pooja Verma
Department of Electronics and Communication Engineering, Sikkim Manipal Institute of Technology
Sikkim Manipal University
Majitar, Rangpo, Sikkim, India
Email: puja20verma@gmail.com

1. INTRODUCTION

The orographic rainfall is characterized as widespread rainfall having rain rate in between 25 mm/hr to 60 mm/hr. This type of rainfall has specific values of the parameter A=300 to 350 and b=0.5 to 0.7 in the popular rainfall-radar reflectivity (Z-R) relation $Z=A\,r^{b}$. This type of rainfall is formed when a low cloud approximate value of 0.85 to 0.9 accompanied by a wind-gust of 6 to 7 km/hr causes rainfall almost 70% of the time during a year over the hills.

At frequencies above 10 GHz, the attenuation of signals due to rain is a serious problem for various necessary communication of systems. Research was done on the attenuation and prediction of rainfall to build a reliable prediction accuracy of these methods and an assessment they acquire for the applicability based on the data base are required which can be collected from the meteorological department. In this research we have collected the rainfall data from Giovani–NASA for the 39 years form 1980-2018.

Many prediction methods for rain attenuation have been discussed, rain covers approximately more than half of time during a year. Because of rain chances of landslides will be increase high which is very dangerous for our surroundings. Nonlinear time series was also used in many researches for the rainfall [1] by using different technique and considering various input as a cause of rain [2]. In India, agriculture is the primary source of economic growth, accurate rainfall forecasting is critical. Some studies explain the regression model, neural networks and clustering to improve rainfall prediction [3]. "The approaches based on autoregressive integrated moving average (ARIMA), the fuzzy time series (FST) model, and the non-parametric method have been discussed in many literatures” [4]. In other studies, a traditional regression model was adjusted to forecast rainfall by iterating existing data and adding error percentage to the input, as well as taking numerous inputs of rainfall such as wind-gust, humidity, and temperature.

Modelling of rainfall is a critical component of responsibility in areas like north east India, where the Indian summer monsoon lasts approximately half the year. There are so many researches and different techniques for prediction. Some literature of ARIMA models compute the missing observations using the Kalman filter [5], which allows a partially diffuse initial state vector. Also, spatial autoregressive moving averages (SARMAS) algorithm calculates an approximation of the multiplicative models [6]. Many algorithms compute the fast result for ARIMA models [7] also the error estimates for detecting the possible intervention in the data time series [8]. To calculate the time series data formed by different variations of monthly data, an improved ARIMA is developed, [9] contemplating the high spatiotemporal variation in rainfall distribution, developed an ARIMA model for forecasting and prediction of monthly rainfall [10]. Semi-empirical method is also used for the prediction of rain mainly International Telecommunication Union-Radiocommunication sector (ITU-R) recommended attenuation in slant path link and terrestrial links which affect the propagation path [11]. Scaling the rain attenuation will benefit the quick monitoring of rain attenuation by using artificial neural network [12], [13]. To measure the attenuation time series on satellite-earth link are also done [14]. Evaluation of the forecast accuracy as well as evaluation among the district fashion suited to a time series model [15] for the modelling. A modified ARIMA modeling technique capture time correlation and possibility of distribution records [16]. Some architecture is also used to combine simple tune to ARIMA model [17]. A correction mechanism is run for the sum of the predicted findings in medium and long-term software program failure time forecasting [18]. Effectivity of method in literature can also predict the experiment for the time collection [19], Metro-wheel based ARIMA model shows the stationarity evaluation and transformation [20] also Box-Jenkins emphases to recognize a fitting time series replica [21] with some model of forecasting correctness [22] by combining models is dynamic research area for ARIMA models.

In this paper, we will describe the forecasting of different hill stations with a statistical analysis of prediction using regression model by taking 39 years of historical data of India [23]. Mostly the tropical areas are orogrographic in nature, sudden rain in the environment may causes the landslides which is very big problem for human beings and society and for the agriculture purpose. So, the purpose of this research is to statistically analyses of rainfall prediction by using historical data so that we prevent the human lives from the landslide and other natural disaster caused by rain. To mitigate this problem, we have taken the different tropical region and doing the statistically analyses through the ARIMA model equation and find the different parameters such as mean, standard deviation (SD) and variance after that we also find the function-statistics and percentile-value. Based on these parameters we got the absolute error which can help us to find the prediction of rainfall for future use, as for many aspects rainfall prediction is important for human beings to prevent the risk of landslides and other societal issues.

2. RESEARCH METHOD

We have taken eight regions mention in the Table 1 with twelve different tropical regions, as shown in Figure 1. For different rainfall seasons all regions we have taken are orographic. This affects the temperature and hills of that region. So, we collected the data of all these regions mention in the Table 1 from the Giovani (NASA), to forecasting to be alerted the problems to protect the environment and human lives.

Table 1. Study regions

	State	Region for study
1	Sikkim	Pakyong, Kanchenjunga
2	Meghalaya	Cherrapunji, Dawki
3	West-Bengal	Darjeeling, Ghum
4	Ladakh (Union Territory)	Saser-Kangri, Slot Kangri
5	Arunachal Pradesh	Itanagar
6	Mizoram	Mizoram
7	Tripura	Tripura
8	Nagaland	Nagaland

Climate of these places are subtropical, a lot of rain seen in months from May-September. The work flow is shown in Figure 2. The primary cause of rain in these places has the sudden rainfall due to the natural hazards which threaten human life. So, it is very important to study the area for the betterment of human beings and to prevent the natural hazards. On the other hand, as comparing with winters, summers include a lot of rain and a high average temperature. Rainfall is vital to research to prevent landslides and other difficulties because it is a hilly region with orographic nature.

Figure 1. Study area of north east India [24]

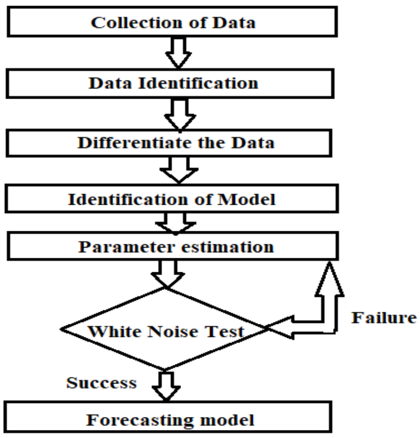

Figure 2. Work flow of models

Thirty-nine years of historical rainfall data for twelve regions i.e., Cherrapunji, Darjeeling, Dawki, Ghum, Itanagar, Kanchenjunga, Mizoram, Nagaland, Pakyong, Saser Kangri, Slot Kangri, and Tripura are smoothed and processed with white noise test. After processing, the data is fed into the ARIMA model, which is fine-tuned for lower prediction error. The model is then calculated in terms of MSE, root mean square error (RMSE), and mean absolute error (MAE) [5].

3. EQUATION AND METHOD

The ARMA model [1]:

$$A(z)y(t) = C(z)e(t) \tag{1}$$

Equation for Cherrapunji:

$$\mathrm{A(z)} = 1 - 1.001\,\mathrm{z}^{-1} \tag{2}$$

$$C(z) = 1 - 0.07672\,z^{-1} - 0.4625\,z^{-2} - 0.4216\,z^{-3}$$

Equation for Darjelling:

$$A(z) = 1 - 1.002\,z^{-1} \tag{3}$$

$$C(z) = 1 - 0.1054\,z\hat{} - 1 - 0.3352\,z\hat{} - 2 - 0.5182\,z\hat{} - 3$$

Equation for Dawki:

$$A(z) = 1 - 1.001\,z^{-1} \tag{4}$$

$$C(z) = 1 - 0.08036\,z\hat{} - 1 - 0.4579\,z\hat{} - 2 - 0.4236\,z\hat{} - 3$$

Equation for Ghum:

$$A(z) = 1 - 1.001\,z^{-1} \tag{5}$$

$$C(z) = 1 - 0.1145\,z\hat{} - 1 - 0.3337\,z\hat{} - 2 - 0.5111\,z\hat{} - 3$$

Equation for Itanagar:

$$A(z) = 1 - 1.002\,z^{-1} \tag{6}$$

$$C(z) = 1 - 0.3374\,z\hat{} - 1 - 0.2235\,z\hat{} - 2 - 0.3993\,z\hat{} - 3$$

Equation for Kanchenjunga:

$$A(z) = 1 - 1.002\,z^{-1} \tag{7}$$

$$C(z) = 1 - 0.05967\, z^{\wedge} - 1 - 0.3725\, z^{\wedge} - 2 - 0.5251\, z^{\wedge} - 3$$

Equation for Mizoram:

$$A(z) = 1 - 1.001\, z^{-1} \tag{8}$$

$$C(z) = 1 - 0.1289\, z^{\wedge} - 1 - 0.378\, z^{\wedge} - 2 - 0.4501\, z^{\wedge} - 3$$

Equation for Nagaland:

$$A(z) = 1 - 1.002\, z^{-1} \tag{9}$$

$$C(z) = 1 - 0.1944\, z^{\wedge} - 1 - 0.3766\, z^{\wedge} - 2 - 0.3927\, z^{\wedge} - 3$$

Equation for Pakyong:

$$A(z) = 1 - 1.002\, z^{-1} \tag{10}$$

$$C(z) = 1 - 0.07438\, z^{\wedge} - 1 - 0.3562\, z^{\wedge} - 2 - 0.5234\, z^{\wedge} - 3$$

Equation for Saser Kangri:

$$A(z) = 1 - 1.001\, z^{-1} \tag{11}$$

$$C(z) = 1 - 0.6208\, z^{\wedge} - 1 - 0.07347\, z^{\wedge} - 2 - 0.2322\, z^{\wedge} - 3$$

Equation for Slot Kangri:

$$A(z) = 1 - 1.002\, z^{\wedge} - 1 \tag{12}$$

$$C(z) = 1 - 0.5181\, z^{\wedge} - 1 - 0.2428\, z^{\wedge} - 2 - 0.1896\, z^{\wedge} - 3$$

Equation for Tripura:

$$A(z) = 1 - 1.001\, z^{\wedge} - 1 \tag{13}$$

$$C(z) = 1 - 0.1924\, z^{\wedge} - 1 - 0.2915\, z^{\wedge} - 2 - 0.4758\, z^{\wedge} - 3$$

4. RESULTS AND DISCUSSION

The developed model is used to forecast monthly precipitation at twelve locations ten steps ahead of time. The lowest error percentage values of the selected region are further counter-confirmed by forecast techniques, which suggest that the observed value is closer to forecasting the average rainfall intensity. Before doing the rainfall prediction, we have done some statistical calculations of these regions, which can help us to find the betterment of the result. In Table 2, regions are listed with their respective altitudes in meters. Apart from this, we can get the mean, SD, and variance in this study. In Table 3, colors are used in the graphs for the prediction of rainfall regions for better understanding.

Table 2. North east stations with varying their altitude

Station	Altitude (m)	Mean	SD	Variance
Cherrapunji	1,430	215.6086	239.2806	57255.23
Dawki	45	214.6788	238.3682	56819.38
Itanagar	320	189.2824	212.8381	45300.06
Slot Kangri	6,000	54.56021	42.12417	1859.694
Darjelling	2,042	225.4848	253.6668	64346.86
Ghum	2,258	199.7583	224.9138	50586.2
Kanchenjunga	8,500	217.8912	245.6023	60320.5
Mizoram	1,548	293.5116	338.7251	114734.7
Nagaland	1,830	230.2049	260.0278	67614.45
Pakyong	1,120	272.8233	294.8636	86944.56
Saser Kangri	7,500	48.11607	27.18314	738.9232
Tripura	939	203.3454	231.6048	53640.77

Table 3. Colors for the prediction of rainfall for different region

Station	Color
Cherrapunji	
Darjelling	
Dawki	
Ghum	
Itanagar	
Kanchenjunga	
Mizoram	
Nagaland	
Pakyong	
Saser Kangri	
Slot Kangri	
Tripura	

Figure 3 depicts the rainfall of three hill stations, Cherrapunji, Darjeeling, and Dawki, at altitudes of 1,430 m; 2,042 m; and 45 m, respectively, over a thirty-nine-year period (1980-2018). As shown in the graph, rainfall at Cherrapunji is quite high when compared to other hill stations. Cherrapunji is noted for having the most rainfall in India. As a result, determining expected precipitation for the three stations, is an early indicator of excessive rainfall.

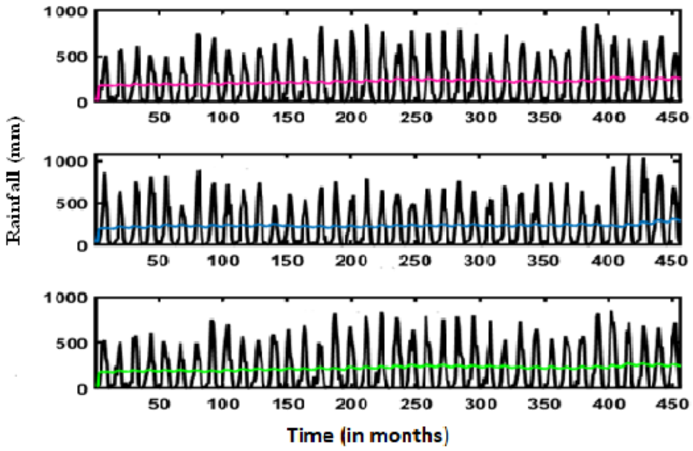

Figure 3. Prediction for three hill stations: Cherrapunji, Darjeeling and Dawki

Similarly, for the region Ghum, Itanagar, and Kanchenjunga are observed the predicted rainfall in Figure 4. Here, Kanchenjunga is having the highest altitude which is very rare as compared to the other regions. This region ranges from 10 °C to 28 °C, the South-West Monsoon brings rain to Kanchenjunga. Figure 5 shows prediction of rainfall for Mizoram, Nagaland, and Pakyong.

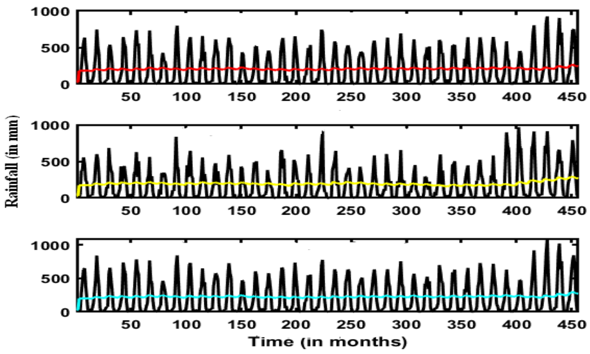

Figure 4. Prediction for Ghum, Itanagar, and Kanchenjunga

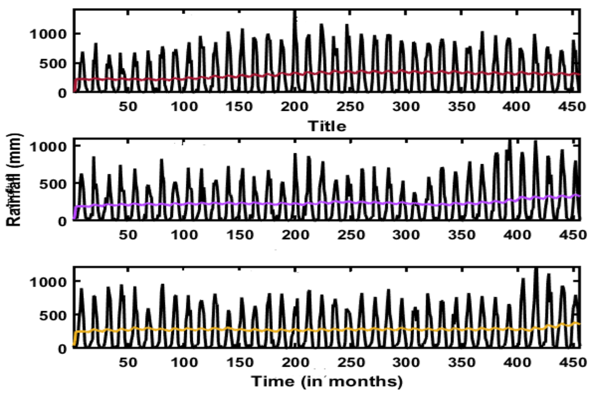

Figure 5. Prediction for Ghum, Itanagar, and Kanchenjunga

For Saser Kangri, Slot Kangri, and Tripura, Figure 6 depicts an actual rainfall and predicted rainfall. Rainfall was correctly predicted by the model that was built over these areas. We have done some error estimation for all these regions using R^2 value, F-statistics, and P-value after doing ten-step ahead prediction for 39 years. F-statistics, also known as fixation statistics, reflect the level of heterozygosity in a dataset that is statistically expected. It's calculated theoretically as the ratio of two scaled sums of squares of the dataset's elements. As a result, it indicates the dataset's variability, while the p-value denotes the level of marginal significance inside a statistical hypothesis test that represents the occurrence of a specific feature within the data set.

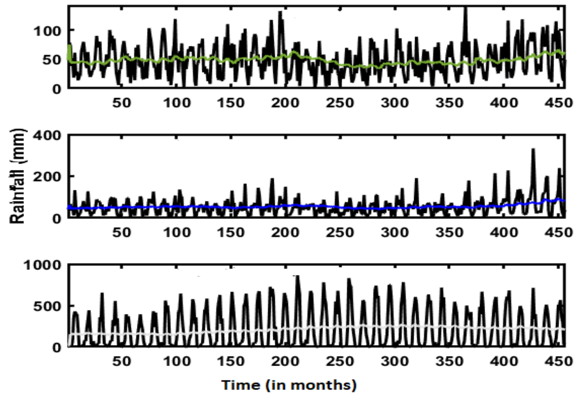

Figure 6. Prediction for Saser Kangri, Slot Kangri, and Tripura

The observed R-squared is reliable, according to the F-test in Table 4. As a result, the model is statistically sound and may be used to complex rainfall scenarios such as forecasting. The outcome of the F-test is further confirmed by the percentile-test (P-test). Table 4 shows that the R-squared is credible and that the data set utilized was not chosen at random. As a result, the prediction model is statistically sound and may be used to complex rainfall scenarios such as orographic forecasting. The outcome of the F-test is further confirmed by the P-test. The residual diagnostics test has been performed before all the models have been tested, and the best models that produce white noise residuals with well-behaved autocorrelation function (ACF) plots have been chosen. Table 5 demonstrates that the model coefficients are less than 10, demonstrating the ease with which complicated variables like orographic rainfall may be predicted. The RMSE value of the dependent variable, such as historical rainfall, as shown in Table 4, reveals a close match to the expected estimate. Scale-free measures of fit, such as MAE, are determined, and a few models are chosen, followed by the best and estimated models based on the lowest RMSE and MAE for prediction. The scatter index, which is lowest in Cherrapunji, Darjeeling, and Tripura, reveals several parameters following rainfall forecast delivers the best outcome and because of their orographic nature, MAE is likewise at a minimum in Cherrapunji, Darjeeling, and Tripura. So, we set the model's na and nc values to 6 and 8 for Darjeeling, but 6 and 4 for Cherrapunji and Tripura, as well as other places, for better results while na and nc are the model's polynomial order and delays, respectively.

Table 4. Parameters for predicted rainfall of the north east region of India (R^2 value, F-statistics, and P-value)

Stations	R^2	F-statics		P-value	
		Theory	Practical	Theory	Practical
Cherrapunji	8.8699	0.8784	0.8784	0.8667	0.5253
Darjeeling	0.9312	0.9148	0.9148	0.9266	0.6742
Dawki	0.9432	0.9028	0.9028	0.9244	0.6601
Ghum	0.8666	0.8916	0.8916	0.8925	0.5503
Itanagar	0.8412	0.8611	0.8611	0.8829	0.5443
Kanchenjunga	0.8752	0.8752	0.8752	0.8805	0.5465
Mizoram	0.7177	0.7322	0.7322	0.7642	0.5100
Nagaland	0.7241	0.7267	0.7267	0.7348	0.5432
Pakyong	0.8790	0.8983	0.8983	0.8760	0.5450
Saser Kangri	0.8780	0.8964	0.8964	0.7811	0.5865
Slot Kangri	0.8044	0.8144	0.8144	0.8948	0.5654
Tripura	0.7047	0.7412	0.7412	0.7787	0.5212

Table 5. Parameters of different regions

Stations	SI	MAE	na	nc	MSE	RMSE
Cherrapunji	0.08812	0.08911	6	4	15.989	22.8465
Darjeeling	0.07671	0.07902	6	8	9.585	15.0693
Dawki	0.0797	0.09211	6	4	14.851	19.7044
Ghum	0.7630	0.100702	6	4	9.408	15.0434
Itanagar	0.6890	0.0998	6	4	13.524	16.2211
Kanchenjunga	0.0770	0.0885	6	4	10.693	16.5281
Mizoram	0.8920	0.0899	6	4	15.113	16.993
Nagaland	0.8820	0.0896	6	4	14.991	22.424
Pakyong	0.0847	0.0891	6	4	14.960	21.7080
Saser Kangri	0.0760	0.0888	6	4	15.801	22.73331
Slot Kangri	0.7740	0.0888	6	4	16.800	22.8991
Tripura	0.0724	0.7691	6	4	14.20	21.8895

5. CONCLUSION

Rainfall, which has a direct impact on agriculture, is the main contributor of natural calamities such as landslides and also various other factors due to rainfall in these regions. As a result, we need to mitigate of this problem, we must forecast the event at an early stage. The regression model that was optimized this problem has an acceptable error value for different orographic regions that can be make accurate predictions. Rainfall data from more stations at higher altitudes will be required in the future to validate the improved rain forecast model.

ACKNOWLEDGEMENTS

Author thanks to TMA Pai research grant from Sikkim Manipal Institute of Technology, fund provided by ISRO-RESPOND project also acknowledged to the Goddard Earth Sciences Data and Information Services Center (GES DISC), National Aeronautics and Space Administration, developed and maintains the Giovanni online data system, which was used to create the analysis and visualizations used in this work (NASA).

REFERENCES

[1] H. Rahman, R. Karuppaiyan, P. C. Senapati, S. V Ngachan, and A. Kumar, "An analysis of past three-decade weather phenomenon in the mid-hills of Sikkim and strategies for mitigating possible impact of climate change on agriculture," *Climate Change in Sikkim: Patterns, Impacts and Initiatives*, pp. 1–18, 2012.

[2] P. Guhathhakurta, "Long-range monsoon rainfall prediction of 200 for the districts and sub-division Kerala with artificial neural network," *Current Science*, vol. 90, no. 6, pp. 773–779, 2006.

[3] P. Burlando, R. Rosso, L. G. Cadavid, and J. D. Salas, "Forecasting of short-term rainfall using ARMA models," *Journal of Hydrology*, vol. 144, no. 1–4, pp. 193–211, Apr. 1993, doi: 10.1016/0022-1694(93)90172-6.

[4] H. R. Wang, C. Wang, X. Lin, and J. Kang, "An improved ARIMA model for precipitation simulations," *Nonlinear Processes in Geophysics*, vol. 21, no. 6, pp. 1159–1168, Dec. 2014, doi: 10.5194/npg-21-1159-2014.

[5] P. S. Lucio, F. C. Conde, I. F. A. Cavalcanti, A. I. Serrano, A. M. Ramos, and A. O. Cardoso, "Spatiotemporal monthly rainfall reconstruction via artificial neural network – case study: south of Brazil," *Advances in Geosciences*, vol. 10, pp. 67–76, Apr. 2007, doi: 10.5194/adgeo-10-67-2007.

[6] R. Kohn and C. F. Ansley, "Estimation, prediction, and interpolation for ARIMA models with missing data," *Journal of the American Statistical Association*, vol. 81, no. 395, pp. 751–761, Sep. 1986, doi: 10.1080/01621459.1986.10478332.

[7] A. I. McLeod and P. R. H. Sales, "Algorithm AS 191: An algorithm for approximate likelihood calculation of ARMA and seasonal ARMA models," *Applied Statistics*, vol. 32, no. 2, p. 211, 1983, doi: 10.2307/2347301.

[8] G. Melard, "Algorithm AS 197: A Fast Algorithm for the Exact Likelihood of Autoregressive-Moving Average Models," *Applied Statistics*, vol. 33, no. 1, p. 104, 1984, doi: 10.2307/2347672.

[9] S. Swain, S. Nandi, and P. Patel, "Development of an ARIMA model for monthly rainfall forecasting over Khordha District, Odisha, India," 2018, pp. 325–331.

[10] L. da S. Mello and M. S. Pontes, "Unified method for the prediction of rain attenuation in satellite and terrestrial links," *Journal of Microwaves, Optoelectronics and Electromagnetic Applications*, vol. 11, no. 1, pp. 1–14, Jun. 2012, doi: 10.1590/S2179-10742012000100001.

[11] M. A. Samad, F. D. Diba, and D.-Y. Choi, "Rain attenuation scaling in South Korea: Experimental results and artificial neural network," *Electronics*, vol. 10, no. 16, p. 2030, Aug. 2021, doi: 10.3390/electronics10162030.

[12] M. Grabner, O. Fiser, V. Pek, P. Pechac, and P. Valtr, "Analysis of one-year data of slant path rain attenuation at 19 and 39 GHz in Prague," in *2017 11th European Conference on Antennas and Propagation (EUCAP)*, Mar. 2017, pp. 2361–2364, doi: 10.23919/EuCAP.2017.7928593.

[13] T. S. Ibiyemi, M. O. Ajewole, J. S. Ojo, and O. O. Obiyemi, "Rain rate and rain attenuation prediction with experimental rain attenuation efforts in south-western Nigeria," in *2012 20th Telecommunications Forum (TELFOR)*, Nov. 2012, pp. 327–329, doi: 10.1109/TELFOR.2012.6419213.

[14] S. Das and A. R. Jameson, "Site diversity prediction at a tropical location from single-site rain measurements using a Bayesian technique," *Radio Science*, vol. 53, no. 6, pp. 830–844, Jun. 2018, doi: 10.1029/2018RS006597.

[15] Z. A. Farhath, B. Arputhamary, and L. Arockiam, "A survey on arima forecasting using time series model," *Int. J. Comput. Sci. Mobile Comput*, vol. 5, no. 8, pp. 104–109, 2016.

[16] W. Jacobs, A. M. Souza, and R. R. Zanini, "Combination of Box-Jenkins and MLP/RNA models for forecasting," *IEEE Latin*

America Transactions, vol. 14, no. 4, pp. 1870–1878, Apr. 2016, doi: 10.1109/TLA.2016.7483528.
[17] S. I. Vagropoulos, G. I. Chouliaras, E. G. Kardakos, C. K. Simoglou, and A. G. Bakirtzis, "Comparison of SARIMAX, SARIMA, modified SARIMA and ANN-based models for short-term PV generation forecasting," in *2016 IEEE International Energy Conference (ENERGYCON)*, Apr. 2016, pp. 1–6, doi: 10.1109/ENERGYCON.2016.7514029.
[18] R. N. Calheiros, E. Masoumi, R. Ranjan, and R. Buyya, "Workload prediction using ARIMA model and its impact on cloud applications' QoS," *IEEE Transactions on Cloud Computing*, vol. 3, no. 4, pp. 449–458, Oct. 2015, doi: 10.1109/TCC.2014.2350475.
[19] T. Hirata, T. Kuremoto, M. Obayashi, S. Mabu, and K. Kobayashi, "Time series prediction using DBN and ARIMA," in *2015 International Conference on Computer Application Technologies*, Aug. 2015, pp. 24–29, doi: 10.1109/CCATS.2015.15.
[20] G. Liu, D. Zhang, and T. Zhang, "Software reliability forecasting: singular spectrum analysis and ARIMA hybrid model," in *2015 International Symposium on Theoretical Aspects of Software Engineering*, Sep. 2015, pp. 111–118, doi: 10.1109/TASE.2015.19.
[21] S. Wichaidit and S. Kittitornkun, "Predicting SET50 stock prices using CARIMA (Cross Correlation ARIMA)," in *2015 International Computer Science and Engineering Conference (ICSEC)*, Nov. 2015, pp. 1–4, doi: 10.1109/ICSEC.2015.7401453.
[22] K. Yunus, T. Thiringer, and P. Chen, "ARIMA-based frequency-decomposed modeling of wind speed time series," *IEEE Transactions on Power Systems*, vol. 31, no. 4, pp. 2546–2556, Jul. 2016, doi: 10.1109/TPWRS.2015.2468586.
[23] G. P. Measurement, "Giovanni," *NASA*, 2022. https://gpm.nasa.gov/data/sources/giovanni (accessed Mar. 01, 2022).
[24] Mapping Digiworld Pvt Ltd, "North-East India Map," 2022. https://www.mapsofindia.com/maps/northeast/sevensisters.htm (accessed Mar. 01, 2022).

BIOGRAPHIES OF AUTHORS

Pooja Verma received her first degree from CCS University, Computer Science, Ghaziabad, Uttar Pradesh, in 2009. She has also master's degree from Gautam Budha University, Wireless Communication Networking, Greater Noida, in 2014. She is pursuing Ph.D. degree from the Sikkim Manipal Institute of Technology, Sikkim Manipal University, Sikkim, India. She is currently a research scholar. Her main research interests focus on remote sensing, artificial intelligence, data modeling and radio propagation, geoscience and frequency signal. She is getting the TMA Pai research grant from Sikkim Manipal Institute of Technology. She can be contacted at email: puja20verma@gmail.com.

Dr. Amrita Biswas is presently working as Associate Professor in the department of Electronics and Communication Engineering and Deputy Registrar (Administration) in Sikkim Manipal Institute of Technology. She completed her B. Tech in 2004 and M. Tech in 2008 from SMIT. She received her Ph.D. Degree on the topic 'Development of algorithms for human face recognition' in 2016 from SMU. Her area of research includes artificial intelligence, machine learning, pattern recognition, and data science. She has published papers on computer vision and image processing in various Journals and Conferences. She has also guided several projects in the field of machine learning and artificial intelligence. One of the guided projects- Smart face recognizer using AI won the first prize in Coursera Show Your Skill Lite, 2020. She can be contacted at email: amrita.a@smit.smu.edu.in.

Dr. Swastika Chakraborty is a professor in the Electronics and Communication Engineering Department, Narula Institute of Technology, Kolkata, India. Her research interests include tropospheric radio wave propagation and its associated climatology. She has authored several research publications and carried out different extramural projects sponsored by Govt. agencies. She can be contacted at email: swastika1971@gmail.com.