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Research Article

Verification of Rain Model for Year 2021 for Selected Areas of India Prone to Drought

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Abstract

In this work, the rain model for the areas of India which are prone to drought – is investigated based on four methods. These methods are: The Time Series method, The Root Mean Square (RMS) method, The Fast Fourier Transform (FFT) method, and the Artificial Neural Network (ANN) method. The predicted rain amount for each of the areas is taken as the average result obtained by each of these methods. One has to keep in mind that the rainfall in these areas are highly erratic. The predicted rainfall is compared with the actual rainfall in these areas. The accuracy of the model is based on the average of the percentage deviation from the actual rainfall. The rainfall is considered as normal by the Indian Meteorological Department (IMD) is within 19% of the actual rain amount.

Keywords: Areas of India; ANN; FFT; Prone to Drought

Introduction and Literature Survey

India has one of the largest area in the world which is suitable for cultivation and where crops can be planted round the year. Unfortunate fact is that about two third of these areas are dependent upon monsoon rain and are without any other irrigation facilities [1]. Other relevant references in this respect can be seen in [2-5].

The fact of the matter is that the rain is highly unpredictable in many areas of India. As a consequence, the farmer's income is highly uncertain. The farmer has to invest just about all his money mainly borrowed from the banks or money lenders at extremely high interest rate. The others involved such as fertilizer suppliers, machinery owners who own tractors to till the land, or the field owners from whom the farmers rent the field - collect money in advance. Thus, in the case of crop failure due to the lack of rain- the risk is borne entirely by the farmer alone. If the rain is not sufficient then the farmer cannot pay back the loan and many commit suicide.

The south-west monsoon rains arrive in the month of June and the four months starting with this month are considered as Monsoon rains. About 66.7% of India's crops are irrigated primarily by these rains [1]. Poor Monsoon rains adversely affect the water supply of the entire country. It affects water availability from rivers, dams and reservoirs, wells etc.

If a reliable model for rain prediction is developed to forecast the amount well in advance then the farmer's uncertainties can be avoided thereby many deaths due to suicides can be decreased. The important areas where one reads about suicides are Vidarbha, Marathawada, Telangana, and Jharkhand where the rainfall is highly unpredictable. The picture of water scarcity and farmers suicides are given in [6-27].

The objective of this work is to predict the monsoon rainfall amount about 7 months in advance so that the farmer can weigh his risk about investment involved in various needs in this respect. The expenses are towards the purchasing of fertilizers, and other

supplies. The information in advance provides him with opportunity to bargain with field owners about the rates he is willing to pay given the amount of expected rainfall.

Figure 1 shows areas, among others, Marathawada, Vidarbha, Telangana and Jharkhand which have been selected for study as the rainfall in these areas are quite erratic. These areas lie in the shadows of the Western Ghats as the south-west Monsoon approaches India from this direction. The Eastern Ghats are not as high as the Western Ghats to pose as a barrier in this respect.

Figure 1: Location of Jharkhand, Telangana, Vidarbha, and Marathawada between the Eastern and Western Ghats of India0

The water shortages in India and particularly in these areas are discussed in [6-27]. In these references, one can also find the topic of farmer's suicides. One needs to also understand that the farmers face added problems because when the crop has very good yield (bumper crop), the prices of their produce crash because of several types of export restrictions and the lack of demand in the internal market. Such restrictions in export are not there in many industrial sectors. This way, the farmers suffer due to under or over production. Added to this, the fact remains that the interest rates of borrowing in India are high as compared to those in the industrialized countries where the farmers get much more subsidies from their respective governments.

The lack of rain affects hydro power generation as well as water supply in the cities [28].

Methodology

In this work, the calculations of the rainfall amount are based on four methods which are: (1) the Time Series method, (2) the Fast Fourier Transform method (FFT), (3) the Artificial Neural Network method (ANN), and Root Mean Square method (RMS). The details about these methods can be known by going through references [29-32].

In the RMS method one has to carry out the linear regression analysis based on minimizing the error of data points from the regression line using root mean square (RMS) values. This is done by taking the data over 32 years period. It is carried out for each of the months separately over time history of 32 years.

In the Time Series method, each of the months (June, July, August, and September) are considered as separate seasons. Again, one looks at the time history of 32 years just like in the previous method. However, here the minimization is taken by combining each of the four seasons (June, July, August, and September).

In the ANN method one has to train the network using a batch of 32 year history – one at a time going back to the year 1873. Here, for every 32 years of data used as an input and the 33rd year data is used as the output. In this way, one progresses to the current year. Having trained the network this way, then, similar process is used for the prediction of the rainfall data expected in the year 2021.

In other words, one expresses the relation of input and output using a linear system of equation

$$\{O\} = [W] \{I\} \quad (1)$$

where {O} and {I} are output and input vectors of sizes mx1 and nx1 respectively. The size of the weight matrix [W] is mxn.

While training, various sets of input vectors and output vectors are used and the search is for the elements of the [W] matrix which minimizes the errors in Eq. (1). After the minimization, the output vector is determined for the new input vector using the optimized matrix [W].

Results and Discussions

One has to attempt the problem of forecasting well ahead of time. Even the Indian Meteorological Department (IMD) comes up with its forecast at the just beginning of the monsoon in April – May and then it revises its forecast sometimes in July [29]. Even then, many times its forecasts are not that accurate. Other researchers mentioned in the references have also not addressed this issue.

The author took up this issue by choosing four different scientific methods in order to express the results in a simple manner so

that the farmers can take reasonable precaution in his or her planning for the next crop.

Finally, the average value of the results given by four methods is used for the actual forecast.

Figure 2 to 5 show the actual rainfall amounts in the areas of interest - Jharkhand, Vidarbha, Telangana, and Marathawada. The amount for Jharkhand varies around 104 centimeters roughly, and the average value is given in table 1 for years between 1989 to 2020. Table 1 shows the results by different methods mentioned earlier. The prediction was based on the average value of all these methods. This table shows that the results of various methods differ from each other over a wide range. However, the average value (the predicted value) is quite close to the actual rain.

In figure 3, the rainfall values for Vidarbha are shown. Here, in table 2, four methods yield results which are close to each other. The predicted value is more than that of Jharkhand but well within the acceptable range of 19%. Figure 3 shows that the rainfall amounts do not vary too much from one year to another. This year's rainfall is close to the 32 year average value.

Method	Year	June	July	August	September	Total	Percentage error from actual
RMS	2021	11.1	33.1	27.8	18.3	90.3	9.8
Time series	2021	22.7	39.0	35.8	24.9	122.4	22.3
FFT	2021	22.9	42.0	29.3	24.6	118.8	18.7
ANN	2021	8.7	16.1	18.8	8.4	52.0	48.1
Predicted Average	2021	16.4	32.6	27.9	19.1	95.9	4.2
Actual rain	2021	26.7	32.2	20	21.2	100.1	0
32year average	2021	19.5	32.8	30.2	21.8	104.2	

Table 1: Rain forecast in centimeters for Jharkhand during 2021 monsoon months.

Figure 2: Total rainfall history of Jharkhand.

Figure 3: Total rainfall history of Vidarbha.

Method	Year	June	July	August	September	Total	Percentage error from actual
RMS	2021	19.5	34.7	27.3	20.8	102.3	5.6
Time Series	2021	20.7	28.9	27.2	24.6	101.5	4.7
FFT	2021	19.4	29.0	31.2	22.0	101.6	4.9
ANN	2021	27.8	35.6	37.2	21.6	122.2	26.1
Predicted Average	2021	21.9	32.1	30.7	22.3	106.9	10.3
Actual Rain	2021	20.1	29.6	17.5	29.7	96.9	0
32 Year Average		19.2	30.8	28.5	16.8	95.4	

Table 2: Rain forecast in centimeters for Vidarbha during 2021 monsoon months.

The yearly rainfall values for Telangana are shown in figure 4. One can see that the actual rain amount values in last 32 years mostly remain quite low with the exceptions at either ends where the rainfalls have been far in excess of the normal values which can also be seen in table 3. The 32 year average value is 59.2 centimeters (cms), whereas this year's amount has been 104.4 cms. The predicted value is far off from the actual rain value because the prediction was based on average of the four methods – all of which predicted far lower values than the actual rainfall value.

Finally, the rainfall values for Marathawada are plotted in figure 5 and details of the results obtained by various methods are given in table 4. The results of each of the four methods are not far off from the actual rain value. Naturally, the predicted value being the average of each of the value yielded by various methods – is also close to the actual rain value.

Table 5 shows the results of the each of the areas and the average of the absolute values of errors between the actual rain and the predicted rain amounts. The average error value of this model is 15.5% within the limit of 19%. It shows that the error in case of Telangana was 39.7% - was far higher than the rest of the areas.

Table 6 shows percentage errors in various methods. It shows that the Time Series method result is the best.

Method	Year	June	July	August	September	Total	% Error from actual
RMS Values	2021	6.0	13.1	16.5	10.9	46.5	55.5
Time Series	2021	24.9	23.3	23.8	13.9	85.9	17.7
Fast Fourier Transform (FFT)	2021	5.4	12.5	18.4	11.7	48.0	54.0
ANN Method	2021	19.4	19.9	17.0	15.5	71.7	31.3
Predicted Amount	2021	13.9	17.2	18.9	11.7	63.0	39.7
Actual Rain	2021	19.5	36.6	19.3	29	104.4	0
32 Year Average		10.6	16.8	19.1	12.8	59.2	

Table 3: Rain forecast in centimeters for telangana during 2021 monsoon months.

Figure 4: Total rainfall history of Telangana.

Figure 5: Total rainfall history of Marathawada.

Method	Year	June	July	August	September	Total	Comments
RMS	2021	21.9	31.3	25.1	18.1	96.3	2.5
Time Series	2021	26.2	24.6	25.1	14.7	90.6	8.3
FFT	2021	20.0	26.9	20.5	18.0	90.9	8.0
ANN	2021	22.9	18.0	17.3	28.2	86.4	12.6
Predicted - Average of Above	2021	22.8	25.2	22.0	19.7	91.1	7.8
Actual Rain	2021	18.1	24.3	17.3	39.1	98.8	0.0
32 Year Average		19.3	30.3	27.8	16.6	94.1	

Table 4: Rain forecast in centimeters for Marathwada during 2021 monsoon months.

Area	Jharkhand	Vidarbha	Telangana	Marathawada	Average Percentage error
Predicted percent error by author	4.2	10.3	39.7	7.8	15.5

Table 5: Average error in calculations for all areas.

Area	Rms	Time series	FFT	ANN
Jharkhand	9.8	22.3	18.7	48.1
Vidarbha	5.6	4.7	4.9	26.1
Telangana	55.5	17.7	54	31.3
Marathawada	2.5	8.3	8	12.6
Average percentage error	18.4	13.3	21.4	29.5

Table 6: Percentage error in various methods.

Conclusions

In this research work, the rainfall history of past 32 years was used as a basis of rainfall amount prediction for the current year. The rainfall history plots showed erraticism whose distributions generally follow a normal distribution. The farmers need predictions in a simple way to plan for expenditures in the coming year.

In this research work, four methods were used to arrive at the result for forecasting. The prediction was based on the average of the four methods as the criteria. The author's model has the capability for forecasting 7 months in advance of the beginning of the rainy season starting in the month of June.

The farmers borrow money at a high interest rate from banks, and money lenders - to pay for seeds, fertilizers, or landowners rent. These people collect money in advance-much before the farmers can sell their crops. In this way, these farmers bear all the risks if the crop fails due to scanty rainfall. In advanced industrialized countries, such farmers are heavily subsidized by their respective governments which the Indian government does very little in comparison [33-37].

This year's forecast falls within 19 percent in the three out of four areas. In case of Telangana, the error was much higher but overall, the total error for all four areas – it was 15.6 percent (Table 5).

Bibliography

1. The percentage of irrigated land in India is about.

2. A drink of clean water.

3. Water Scarcity in India: A Human Crisis I India Loud and Clear I EP 7.

4. India's water crisis: It is most acute for women - Down To Earth.

5. "Second wettest Sept in 27 years bridges Monsoon deficit" (2021).

6. "Droughts, water shortage: Here's why Marathwada isn't giving up Sugarcane" (2020).

7. "Six out of 9 major dams in Marathwada reel under water shortage" (2019).

8. "How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood" (2019).

9. "Farmers stare at drought as Jharkhand rain deficit crosses 50%" (2019).

10. "Jharkhand witnesses 35% rainfall deficit" (2019).

11. "What lack of rainfall could mean...?".

12. Erratic Monsoon Haunts India; 33% Rainfall Deficit in June (2019).

13. How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood (2019).

14. Staring at acute water shortage, India witnesses driest June in 5 years (2019).

15. Singh K., *et al*. "A Study on Variability in Rainfall over India Contributed by Cyclonic Disturbances in Warming Climate Scenario". *International Journal of Climatology* 40.6 (2020): 3208-3221.

16. Mathur R and AchutaRao K. "A Modelling Exploration of the Sensitivity of the India's Climate to Irrigation". *Climate Dynamics* 54 (2020): 1851-1872.

17. Prathipati VK., *et al*. "Inconsistency in the frequency of rainfall events in the Indian summer Monsoon season". *International Journal of Climatology* 39.13 (2020): 4907-4923.

18. Southwest Monsoon 2020: Good rains now bring bad news.

19. Heavy rains lash Maharashtra, north India reels under sultry weather.

20. NMC likely to get only 50% of raw drinking water demand (2018).

21.

22. Water crisis looms in Vidarbha and Marathwada as summer arrives (2018).

23. "Water Scarcity and Security in India".

24. Telangana's Shocking Statistics: 350 Farmer Suicides in Five Months.

25. Farmer's Suicide in Vidarbha: Everybody's Concern.

26. India's fast-growing cities face water crisis - Phys.org (2015).

27. "Groundwater Recharge" (2008).

28. "The Thirst for Power: Hydroelectricity in a Water Crisis World" (2016).

29. "Rainfall Projections".

30. "Excel - Time Series Forecasting".

31. "Frequency Domain Using Excel".

32. Sharan AM and Balasubramanian R. "Design of Four-Bar Mechanism by Neural Network Methods". *International Journal of Modelling and Simulation* 19.1 (1999): 1-6.

33. Agricultural subsidy.

34. "Water Shortages in India" (2019).

35. "Water crisis looms in Vidarbha and Marathwada as summer arrives" (2018).

36. "The Thirst for Power: Hydroelectricity in a Water Crisis World" (2016).

37. Sharan AM and Balasubramanian R. "Design of Four-Bar Mechanism By Neural Network Methods". *International Journal of Modelling and Simulation* 19.1 (1999): 1-6.

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