

Modelling and Verification of Rain Amount for the Drought Prone Areas of India for the Year 2024

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Abstract

In this research work four methods are used to calculate the total amount of rainfall for the year 2024. These methods are: The Root Mean Square (RMS) method, The Fast Fourier Transform (FFT) method. The predicted rain amount for the coming year is the average of the four methods.

The prediction of this research work is compared with the average value of the last 32 years of rainfall history. The reason for this average value comparison is that the distribution of the rainfall has been earlier found to have a normal distribution where the most probable value is the mean value for this kind of distribution [5].

Introduction and Literature Survey

India is a vast country where the rainfall pattern in different regions is very different. Some areas of India are very drought prone. In such areas major problem is faced by the farmers who have to come up with the finances much earlier than the beginning of monsoon i.e. when they plant the crop. The farmers have to borrow money at high interest rate either from the banks or from the money lenders and the failure of the crop results in - sometimes their committing suicide. Therefore, it is very desirable that the prediction be made well in advance of the actual rain.

This year in India, the rainfall has been very erratic thereby affecting the time of the planting of seeds. The information about this year's rain can be seen in [1-4].

In India about 66% of the land for farming is dependent on monsoon rain as they do not have other facilities for Irrigating their fields. Therefore, the vagary of nature creates vast uncertainty in their output.

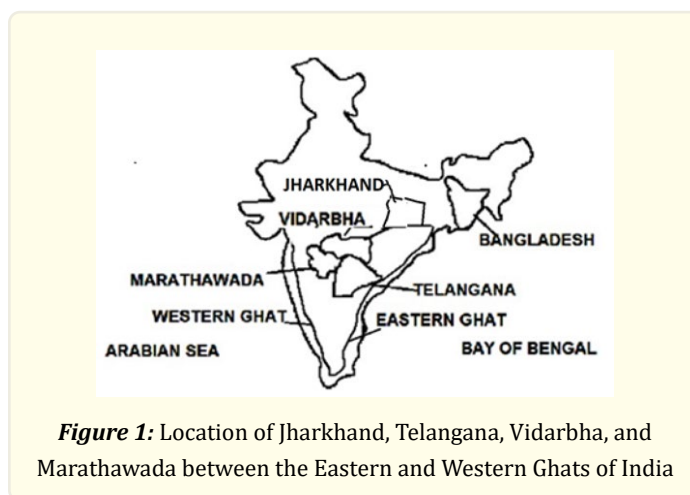
The present work deals with the areas such as, Vidarbha, Marathwada, Telangana, and Jharkhand where the rainfall is highly unpredictable [6-36].

Not only agriculture but also the hydropower is dependent on the rain [37]. This hydropower is useful to the farmers who may want to use pumps for irrigation.

It should be noted that the farmers in India receive much smaller subsidy as compared to the ones in the Western countries where farming is heavily subsidized [38].

The forecasting for rainfall had been undertaken about seven months in advance so that the farmers could have sufficient time to plan their next year's crop. This advance forecasting is not done by the government's own agency named as the Indian Meteorological Department (IMD); This agency makes its forecast just about two months ahead of the beginning of the monsoon season which starts in June. This does not help the farmers because many of them rent the land from the landowners around the month of April which is also the forecasting month by the IMD. The farmers cannot plan much if they depend entirely on the IMD.

Figure 1 shows the areas of Maharashtra, Telangana, Jharkhand, and Vidarbha. In these areas the monsoon rain approaches from the southwest direction. One can see in this figure that there are two mountain ranges as the monsoon enters India. These two mountain ranges are called the Western and the Eastern Ghats. The western one is higher than the eastern one. Therefore, the areas which fall in the shadows of these mountain ranges experience uncertainty in the rainfall.



Here, the calculations are based on 4 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) method. The details about these methods are given in [39-42].

The calculations in the RMS method involves linear regression based on root mean square (RMS) values. In these calculations one looks at the 32-year-old history. This process is carried out for each of the months which are: June, July, August, and September. The total of all these four month's values are added up to constitute the total rainfall value.

In the Time Series method, each of the months of June, July, August, and September are considered as separate seasons and the computations are performed on this basis. Even here, the calculations are based on past 32 years of rain history.

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 1876. 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 previous year which is 2023. Having trained the network this way, then, a similar process is used for the prediction of the rainfall data expected in the year 2024.

In FFT method, the computations are performed similar to that in the signal processing field. Here, the trend is computed and extended to the new year which is the year 2024.

Results and Discussions

The total values of rain in Jharkhand, Vidarbha, Telangana, and Marathwada are shown in Figures 2 to 5. These figures show the rainfall history of past 32 years. One can see that the rain is quite fast changing from year to year.

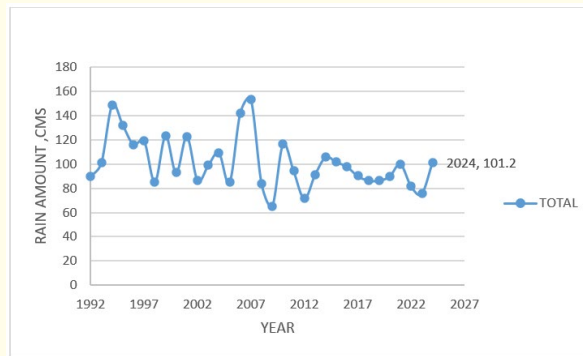


Figure 2: Total Rain Amount in Jharkhand in CMS.

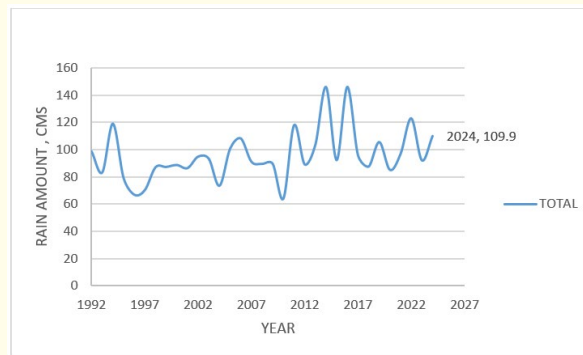


Figure 3: Total Rain Amount Vidarbha in CMS.

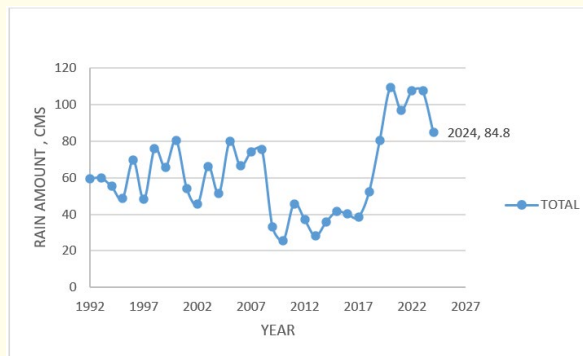


Figure 4: Total Rain Amount in Telangana in CMS.

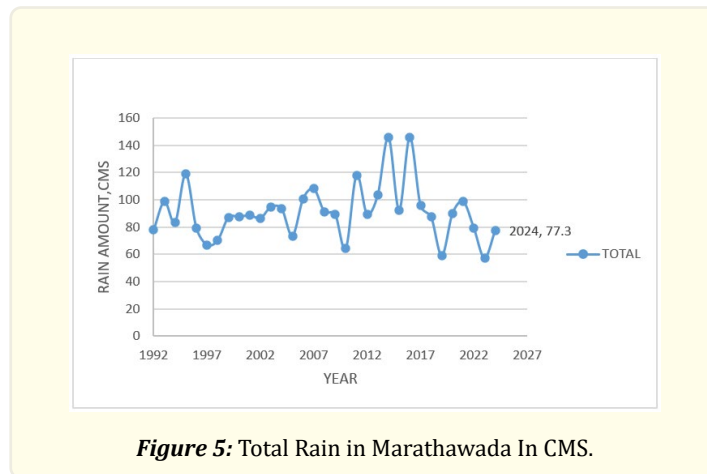


Figure 5: Total Rain in Marathawada In CMS.

Table 1 shows the details of the rainfall in Jharkhand on a month-by-month basis and the total amount. It shows the results obtained by the four methods mentioned earlier. After this, the average is computed and this is the prediction value. The last column shows the errors involved in each of the methods including the error in the 32-year average value. The percentages compared in the last column are from the actual rainfall values in the year 2024. In this particular case, the 32-year average value is very accurate. The predicted value has an error of 13.7%.

<i>Method</i>	<i>Year</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>Total</i>	<i>Percent of Absoute Error from Actual</i>
Time Series	2024	20.1	29.5	24.7	15.8	90.1	10.8
FFT	2024	15.6	18	20.4	15.2	69.2	16.7
ANN	2024	16.5	7.1	25.3	19.4	68.3	21.2
RMS	2024	19.7	31.2	21.3	22.9	95.2	13.7
Average of Four Methods	2024	18	21.5	22.9	18.3	80.7	13.7
32 Year Average	2024	19.0	31.6	30.0	21.8	102.5	0.0
Actual Value	2024	7.35	22.85	42.2	28.8	101.2	10.8

Table 1: Rain Forecast in Centimeters for Jharkhand during 2024 Monsoon Months.

Table 2 shows the results for Vidarbha. Here the predicted value has 7.3% error. On the other hand, the 32 year average value has 13.2% error.

<i>Method</i>	<i>Year</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>Total</i>	<i>Percentage Error from Actual</i>
Time Series	2024	30.6	26.3	24.9	27.7	109.5	0.4
FFT	2024	17.6	31.4	24.8	16.8	90.6	17.6
ANN	2024	12.1	27	29.8	19.4	88.3	19.7
RMS	2024	22.7	33.9	22.7	22.7	101.9	7.3
Average of Four Methods	2024	20.7	29.6	25.5	21.6	97.6	7.3
32 Year Average		18.2	31.9	27.1	18.2	95.4	13.2
Actual	2024	14.7	51.8	22.8	20.6	109.9	0.0

Table 2: Rain Forecast in Centimeters for Vidarbha during 2024 Monsoon Months.

The results for Telangana are shown in the Table 3. Here the predicted value has 3.1% error and the 32-year average value has 27.3% error. Clearly, the predicted value is far more accurate than the 32-year average value.

<i>Method</i>	<i>Year</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>Total</i>	<i>% Absolutr Error from Actual</i>
RMS Metho	2024	8.7	24.7	15.8	21.1	70.4	7.0
Time Series Method	2024	19.1	31.5	29.1	16.7	96.4	
FFT Method	2024	9.3	25.7	18	17.4	70.4	17.0
ANN Method	2024	5.7	28.6	20.4	36.6	91.3	7.7
Average Amount Average of Four Methods	2024	10.7	27.6	20.8	23	82.1	3.1
32 Year Average		10	18.5	18.3	14.4	61.1	27.9
Actual Rain	2024	15.4	29	21	19.4	84.8	0

Table 3: Rain Forecast in Centimeters for Telangana during 2024 Monsoon Months.

Similar results for Marathawada are shown in the Table 4 where the predicted value has error of 4.4% whereas the 32-year average value has error of 18.1%. So, even in this case the predicted value is far more accurate then the 32-year average value.

<i>Method</i>	<i>Year</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>Total</i>	<i>Percent Error</i>
TIME Series	2024	20.1	29.5	24.7	15.8	90.1	10.5
FFT	2024	15.6	18	20.4	15.2	69.2	11.6
ANN	2024	16.5	7.1	25.3	19.4	68.3	23.2
RMS	2024	19.7	31.2	21.3	22.9	95.2	4.4
Average OF Four Methods	2024	18	21.5	22.9	18.3	80.7	4.4
32-Year Average		18.4	30.2	25.4	17.4	91.3	18.1
Actual	2024	16	23	15.1	23.2	77.3	0

Table 4: Rain Forecast in Centimeters for Marathawada during 2024 Monsoon Months16.6.

Table 5 shoes region-wise results based on the predicted value and the 32-year average value. It shows that the predicted value on an average has an error of 6.3% whereas the 32-year average value has an error of 14.8%. It clearly shows the superiority of the prediction model in comparison to the most probable value which has the highest probability. This is because of the nature of the rainfall history which has a normal distribution.

Table 6 shows results of each of the four methods. It shows that the RMS method turns out to be the best among all these methods.

Area	Jharkhand	Vidarbha	Telangana	Marathawada	Average Percentage error
Average of Four Methods	13.7	11.2	3.2	4.4	6.3
32 Year Average	0.0	13.2	27.9	18.1	14.8

Table 5: Average Error in Calculations for all Areas.

Method	Jharkhand	Vidarbha	Telangana	Marathawada	Average
Time Series	10.8	0.4	7.0	10.5	10.3
FFT	16.7	17.6	17.0	11.6	19.7
ANN	21.2	19.7	17.0	23.2	22.9
RMS	13.	7.3	7.7	4.4	8.1

Table 6: Percentage Error in Various Methods.

The Conclusions

In this work four methods were used to forecast the rainfall value for the coming year. The prediction was based on the average of the 4 methods.

1. The results in the Table 5 clearly showed that the prediction model gives better results than the most probable value available do a researcher.
2. The RMS method has the best results among the four available methods that were discussed in this Work.

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