Monsoon Rain Prediction for Jharkhand for the Year 2023

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Abstract— **Monsoon rains account for 90% of the annual rain. The monsoon months are defined as June, July, August, and September. The rainfall estimates for each of these months are made using four methods. These methods are: (1) Artificial Neural Network (ANN) method, (2) the Fast Fourier Transform (FFT) method, (3) the Time Series method, and (4) the Root Mean Square (RMS) method using linear regression. The predicted rain value is the average of the four of these methods. This year, based on the calculations, it is predicted that it will be 16.7% less rain than the past 32 years average**

Index Terms— **Monsoon rain prediction, annual rainfall, rainfall frequency spectrum, El Nino and La Nina influence on rainfall, drought and famine, crop failure**

I. INTRODUCTION AND OBJECTIVE OF RESEARCH

Indians are fortunate that their country has one of the largest areas for cultivation, and crops can be planted round the year. Unfortunately, the Indian farmers - about 2/3 of them have to depend on the monsoon rains without having any irrigation facilities [1-5].

Another important factor to consider is that the farmers have to purchase on cash or credit - seeds, fertilizers, and other supplies including many times - renting of the field for agriculture. The erratic nature of the monsoon rains makes their returns on the investment very risky. Not only this, the interest rates charged by the banks and moneylenders are quite high as compared to those in the industrially advanced countries. Consequently, if the monsoon raina fail then many of these farmers commit suicide.

The failure of the monsoon rain also causes immense hardship to ordinary citizens because the water levels in the rivers and the reservoirs become very low and require rationing of water and in many areas the water is supplied through trucks and trains. The references [6-8] discuss the shortage of water in Tamil Nādu and Jharkhand.

In India, the failure of monsoon rains lead to decrease agriculture production and consequently it decreases the cash available in the rural areas thereby decreasing the demand for goods and services in other sectors of the economy [9].

Recently the shortage of rainfall affected the hydroelectric power generation in California in USA. This state of California was affected by drought for last six years. Similar drought conditions affected the electric power generation in India also.

The rainfall shortage affects the water supply, and power generation using hydro—electricity and is discussed in [10]. Jharkhand has hilly terrain where water flows down quickly. Unfortunately, Jharkhand has shortage reservoirs [11-12]. ,

Lack of monsoon rains affect the reservoir levels and decrease the hydroelectric power generation primarily in the summer months. Many other areas of India also have been feeling extreme water shortages [13-30].

The works of many authors which are important and relevant in this regard are discussed in [31-41]. The monsoon rain prediction by Indian Meteorological Department (IMD) can be seen in [42].

One can see the location of Jharkhand in India in Fig. 1. in view of the monsoon rain affecting lives in so many areas of India, this study has been undertaken to predict well in advance - the availability of water through monsoon rains. This study will help in planning for the water availability during the summer months.

II. RESULT AND DISCUSSIONS

Fig. 2 shows the calculated results of of the Time Series method, the artificial neural network method (ANN), the Fast Fourier Transform method (FFT), the Root Mean Square (RMS) method and the actual rainfall record for the month of June. One can see the details about these methods in [43-45]. In this figure, one sees that be RMS method yields a declining trend , whereas the Time Series method shows increasing trend whereas the actual rainfall varies quite widely and rapidly. The ANN method results remain low but fluctuate quite rapidly.The Time Series and the RMS variations are based on linear regression and are straight lines.

The Table 1 shows the summary of results for all the 4 months including the total values. The predicted amount value is the average of results obtained by these four

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methods. As far as the total values are concerned, the results of the Time Series method and the FFT methods are high whereas the results of the ANN method show quite a low value.

In Fig. 3, the actual results vary over wide range, unlike results obtained by the Time Series method and the RMS method. They show opposite trends – one increasing and the other –decreasing. The actual results vary quite rapidly.

In Fig. 4, the trend for the RMS and the Time Series methods show opposite nature as before. The actual values very rapidly as usual. Even the ANM method shows high fluctuations.

In Fig. 5, the actual values vary rapidly as do the ANN method results. The results of the other methods remain in close vicinity.

The total values of the rain are shown in Fig. 6. Here, all results are closer to each other. Here again, there are sharp variations seen in the case of the actual results and those of ANN method's.

The Fig. 7 shows the amplitude versus frequency number plot of the total rain. Here, frequency numbers 1,3,5 , 6, 8, and 10 are significant frequencies having amplitudes greater than 4 cms, which is quite high.

The Table 1 shows that this year the rainfall amount will be less than the 32 year average; this year there will be about 16.7 % lower rain amount than the average of the past 32 years.

III. Conclusion

In this work four methods were used to compute the forecast of the monsoon rain for the year 2023. The summary of the results was mentioned in the Table 1.

One can conclude the following from these discussions:

1. The actual rain values fluctuate very highly.
2. The Time Series method results and those of the RMS method's have linear variations due to the linear regression analysis.
3. The FFT method results are approximations of the actual curve using harmonic functions.
4. Based on the Table 1 results, this year there will be 16.7% less rain than the past average of the 32 years.
5. Jharkhand has reasonable amount of rain but lacks water storing capacity. Therefore, more reservoirs are needed to be built.

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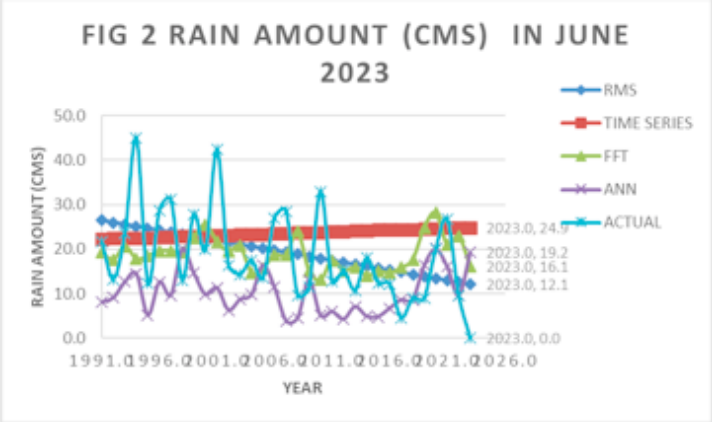
TABLE 1: RAIN FORECAST IN CENTIMETERS FOR JHARKHAND DURING 2023 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
TIME SERIES	2023	24.9	24.9	25.0	25.0	99.8	
FFT	2023	16.1	31.7	27.5	22.9	98.2	
ANN	2023	19.2	19.6	10.7	20.7	70.3	
RMS	2023	12.1	30.5	26.7	18.4	87.7	16.7 % LESS THAN 32 YEAR AVERAGE
PREDICTED VALUE=	2023	15.8	27.3	21.6	20.7	85.4	
32 YEAR AVERAGE		19.0	31.6	30.0	21.8	102.5	

FIG 1 LOCATION OF JHARKHAND, IN INDIA



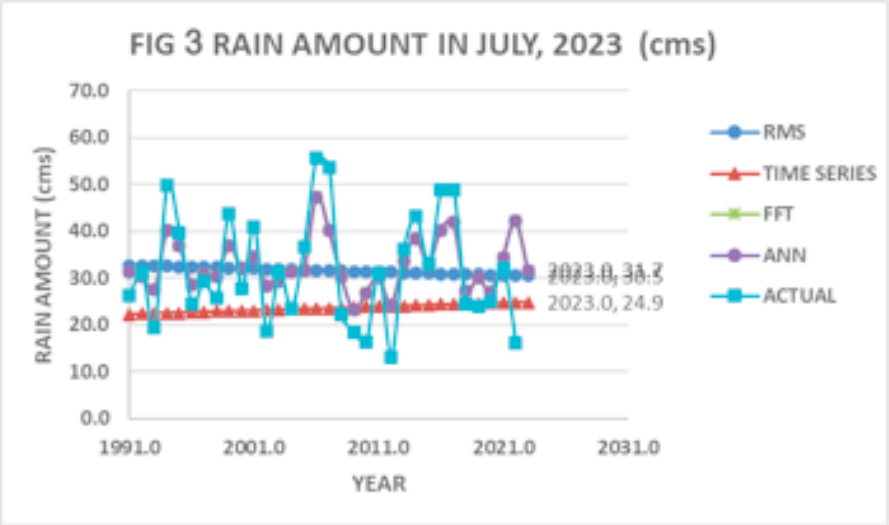


FIG 3 RAIN AMOUNT IN JULY, 2023 (cms)
RAIN AMOUNT (cms)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1991.0
2001.0
2011.0
2021.0
2031.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL
2023.0, 24.9

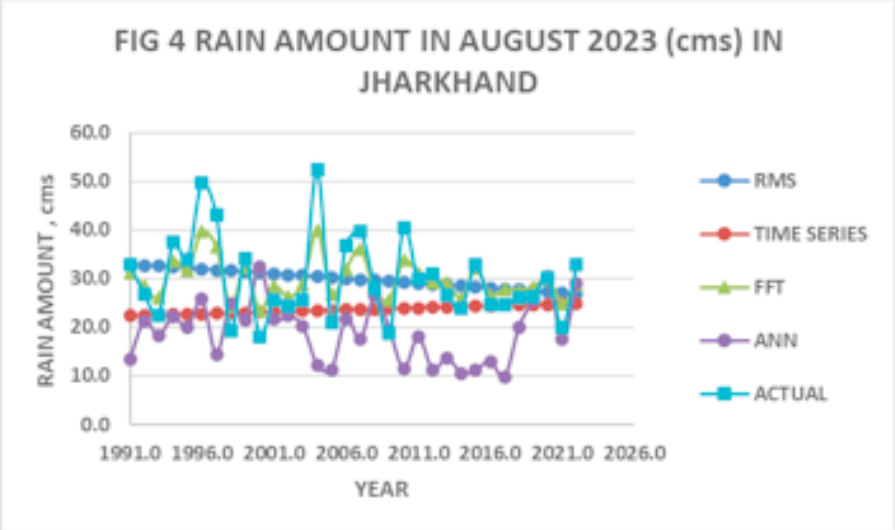


FIG 4 RAIN AMOUNT IN AUGUST 2023 (cms) IN JHARKHAND
RAIN AMOUNT , cms
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1991.0
1996.0
2001.0
2006.0
2011.0
2016.0
2021.0
2026.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

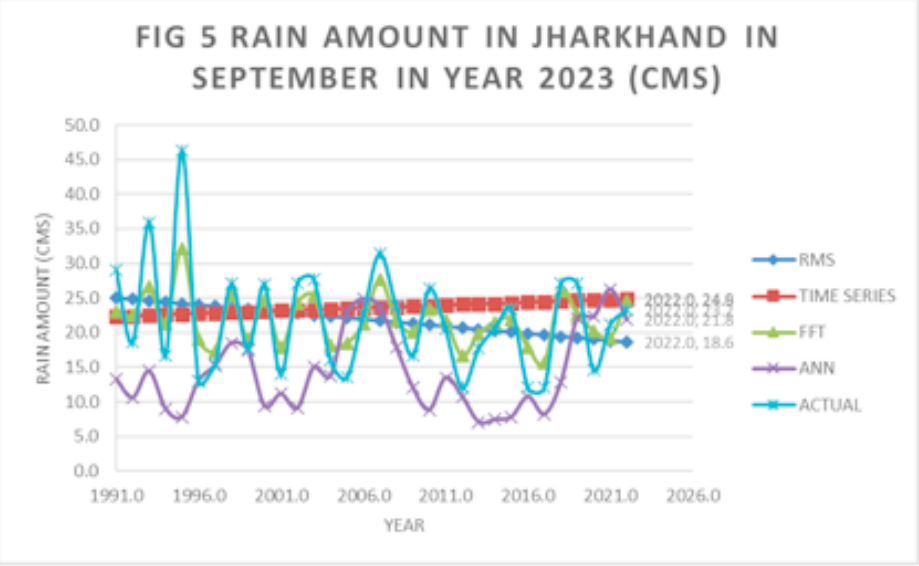


FIG 5 RAIN AMOUNT IN JHARKHAND IN SEPTEMBER IN YEAR 2023 (CMS)
RAIN AMOUNT (CMS)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1991.0
1996.0
2001.0
2006.0
2011.0
2016.0
2021.0
2026.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL
2022.0, 24.9
2022.0, 21.8
2022.0, 18.6

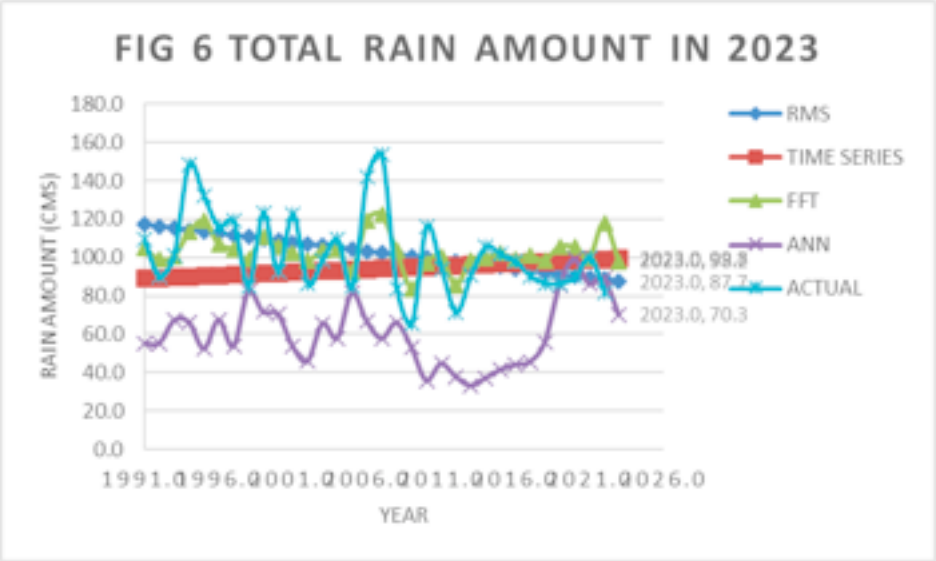


FIG 6 TOTAL RAIN AMOUNT IN 2023
RAIN AMOUNT (CMS)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1991.0
1996.0
2001.0
2006.0
2011.0
2016.0
2021.0
2026.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL
2023.0, 98.8
2023.0, 87.7
2023.0, 70.3

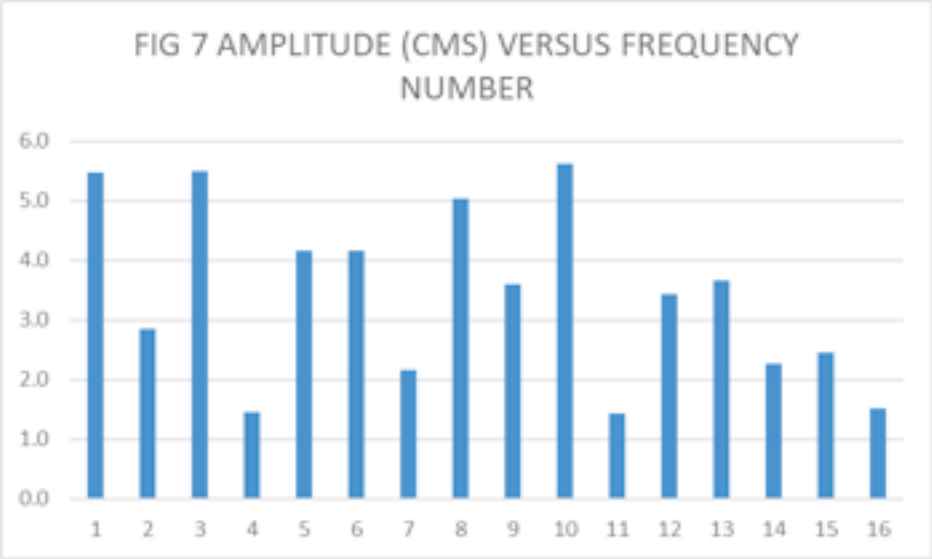


FIG 7 AMPLITUDE (CMS) VERSUS FREQUENCY NUMBER
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16