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Forecasting of Monsoon Rain for Marathawada in the Year 2025

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Abstract - Marathawada is one area where it is very difficult to predict the monsoon rainfall. The reason is that the monsoon rains appear from the southwest direction, and they have to cross a mountain range called the Western Ghats. These mountain ranges are quite high, and they disturb the pattern of the monsoon rain clouds. Similarly, there is another area called Telangana where also it is difficult to predict the rainfall in the coming year monsoon season. What makes matters worse is that the government of India's climate prediction department called the Indian Meteorological Department (IMD) comes out with its prediction in the month of April which does not leave much time for the farmers for the monsoon season preparations. The monsoon season starts from the month of June. To provide greater time to the farmers the present research makes predictions about seven months in advance using the last 32 years data. This research uses four methods and then computes the average result of these methods for the prediction. These methods are (a) the Fast Fourier Transform (FFT) method, (b) the Artificial Neural Network (ANN) method, (c) the Time Series method, and (d) the Root Mean Square (RMS) method. The predicted value is equal to the average of these four methods.

KEYWORDS: Monsoon rain prediction, Annual rainfall, Rainfall frequency spectrum, Flood control, Hydro-power generation

I. WATER SHORTAGE IN MANY MAHARASHTRA REGIONS

Fig. 1 shows the location of Marathwada. The global climate has been changing quite rapidly these days. The impact of this change is reflected in drought, excessive rain, uncertainty in the timing of the rain which hampers with the sowing of the seeds. These difficulties result in shortage of crop production which drives food prices high [1-4].
On an average, the per capita income of the Indians is quite low with the result that the farmers are never able to get high profit in their produce. They have to purchase seeds, fertilizers, and farming equipment mostly on loans. The interest rate is high in India and the system is not very suitable to borrow money at lower interest rates. If the crop fails, then many of these farmers commit suicide every year.

It has been determined that the pattern of rainfall follows a normal distribution [5]. One can read about deficient rain in this area in [6-18]. It must be emphasized that the shortage of water or the lack of rainfall causes the administration to transport water by rail and truck [19-24]]. There is another problem that sugar cane is also produced in these areas which requires heavy amount of water thereby many farmers have much less water available for irrigation [25-30].
Lack of sufficient rain poses problems for hydroelectric power generation [31]. The problem in the crop production is well known to other scientists and one can find their works in [32-37]. The details about various methods used in the rainfall prediction can be seen in [38-40].
In the Time Series method, data for each of the months of June to September is considered as separate season. An overall trend is calculated using linear regression analysis. From this overall trend, the predicted values are calculated.

In the Fast Fourier method, Fourier coefficients are calculated using faster algorithm. Using these coefficients the Fourier series is synthesised and Fourier series trend is determined. Based on this trend, the series is extended to the 33rd year which is the predicted value.

In the ANN method, 32-year data from the year 1877 is used as the input vector and the rain amount in the thirtythird year is used as the output vector - to train the network. After this, the result of next 32 year is obtained by incrementing the record of 1877 by the next record which will be year 1878. Consequently, the output vector becomes the 34th year from the year 1877. In this way, the final output vector will be the year 2024. After training the network this way, the prediction is made using the trained weights for the year 2025. The details about this method can be seen in [40].
The equation relating the input vector {I} and the output vector {0} is given by

$$\{o\} = [W]\ \{I\} \qquad (1$$

where [W] is the wight matrix of the size m x n. The input vector and the output vectors are of sizes n x1 and m x 1 respectively.

II. RESULTS AND DISCUSSIONS

Fig. 2 shows the plots of calculations required in various 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 (RMS) method.

In the RMS method, one has to calculate the mean square root value based on linear regression analysis.

The details of various steps involved in the calculations are shown in Fig. 8.

The results in Figs. 2 to 6 show separately. It includes he results of each of the months and the total values. The total values are shown in Fig. 6. Fig. 7 shows the frequencies of the rainfall during the 32 years.

Fig. 2, shows the rainfall history for the month of June where the Time Series method and the RMS method follow straight line relationship due to linear regression. The actual rainfall values vary abruptly from year to year. The ANN values are generally low and also show sharp variations. Normally, the rainfall values are less in June as compared to July and August which are shown in Figs. 3 and 4 respectively.

Fig. 3 shows that the RMS method has decreasing trend whereas the Time Series method has increasing trend. The actual rainfall values undergo rapid changes. The values in the FFT method and the ANN method do change but not very drastically.

In Fig. 4 the RMS method shows decreasing trend whereas the Time Series method shows increasing trend.

In Fig. 5 one finds that both the Time Series method and the RMS method show increasing trend where the actual rainfall values have very high variations from year to year. The ANN method shows fluctuation in values.

In Fig. 6, the actual values change quite a bit. The RMS method and the Time Series method follow straight line relationships due to linear relationship. The ANN method shows sharp variations, but the amount is less than that of the actual rainfall. The FFT r values do change but not as much as the actual values.

The summary of results is shown in the Table 1. This table shows that the predicted rainfall value for the year 2025 is less than the 32-year average.

Fig. 7 shows that the significant frequencies are 3, 5, 12 and 14 which are above 4 centimeter in amplitude a. The high magnitudes is arising due to complex nature of air flows.

One can see in Fig. 8 the sequence of computation.

III. CONCLUSIONS

Based on this work one can conclude the following:

1. The results in the Table 1 show that the rainfall average of past 32 years is slightly higher than those predicted for 2025.
2. The Fig 7 shows that the rapid change in the rain amount is due to the high magnitudes of many of higher frequencies.
3 The low rainfall history of this area shows sugar cane should not be planted in this area in order to enable other farmers to avail of the water which is scares in this area

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TABLE 1: RAIN FORECAST IN CENTIMETERS FOR MARATHAWADA DURING 2024 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
TIME SERIES	2025	22.1	31.7	26.8	17.7	98.3	
FFT	2025	16.4	32.0	15.9	22.7	87.0	
ANN	2025	14.4	11.7	18.6	16.3	61.1	
RMS	2025	22.5	29.1	19.0	22.7	93.2	
PREDICTED VALUE	2025	18.8	26.1	20.1	19.8	84.9	RAIN BELOW 32-YEAR AVERAGE
32-YEAR AVERAGE		18.3	29.9	24.2	18.5	90.9	

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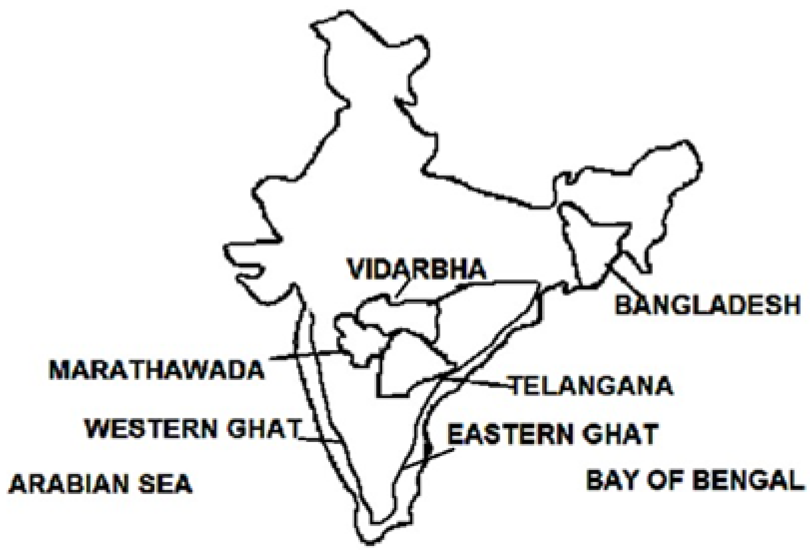
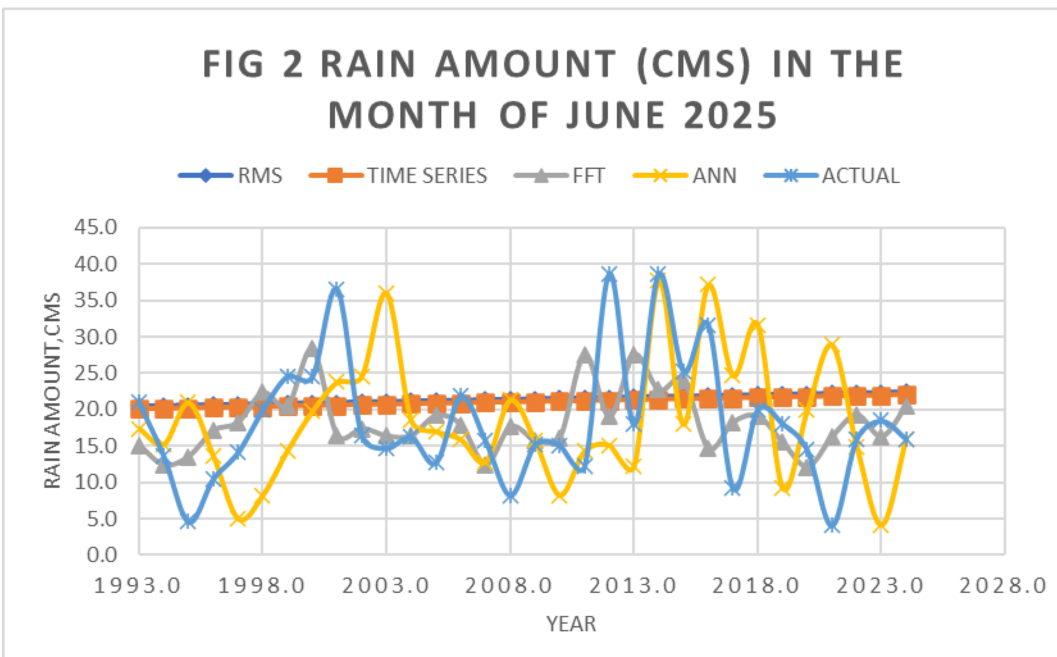


FIG. 1 LOCATIONS OF MARATHAWADA. VIDARBHA.
AND TELANGANA BETWEEN WESTERN AND EASTERN GHATS



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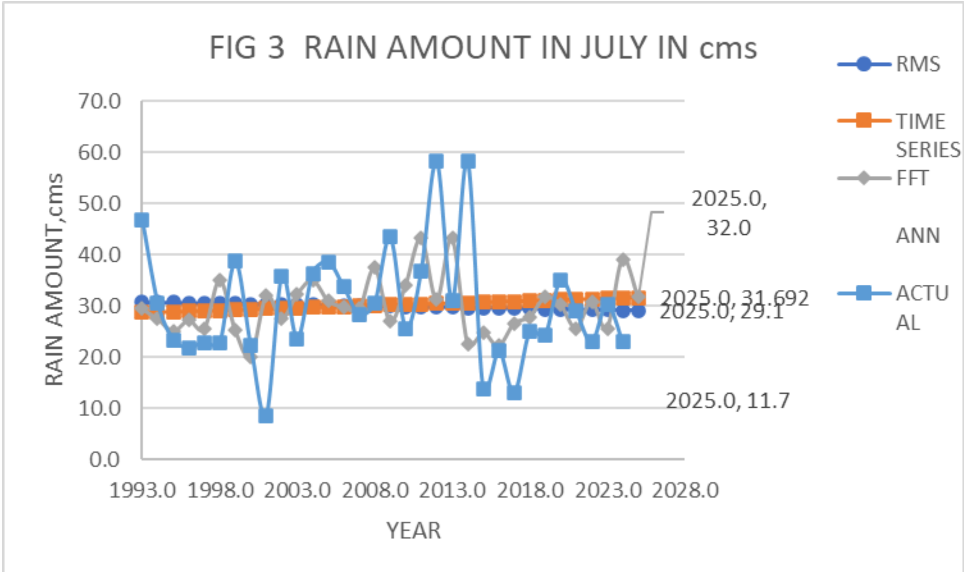
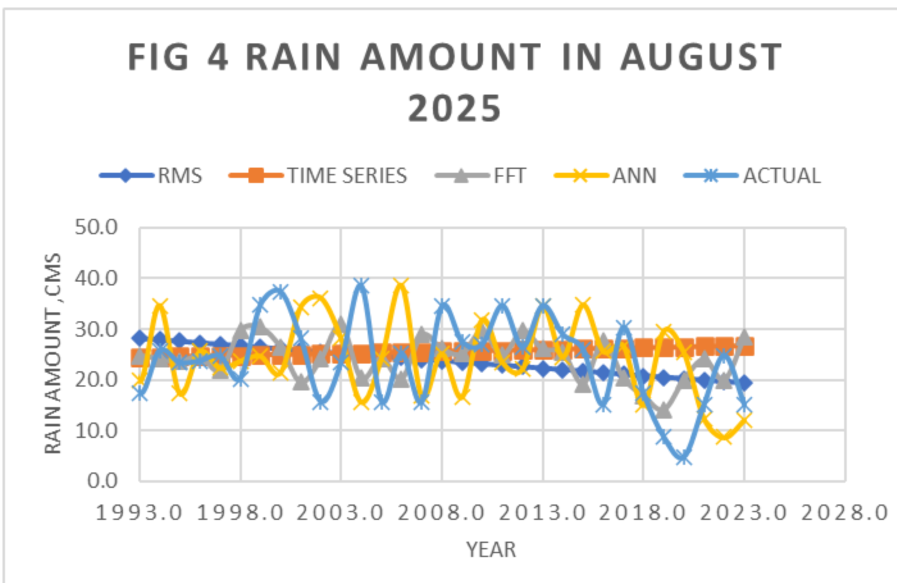




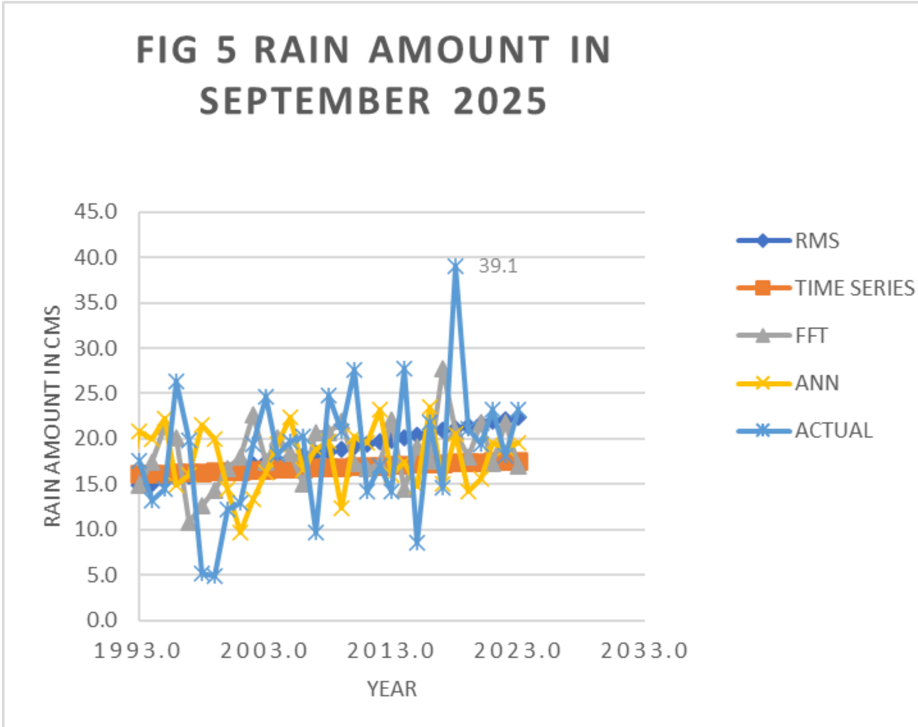


FIG 5 RAIN AMOUNT IN SEPTEMBER 2025
RAIN AMOUNT IN CMS
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
39.1
1993.0
2003.0
2013.0
2023.0
2033.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

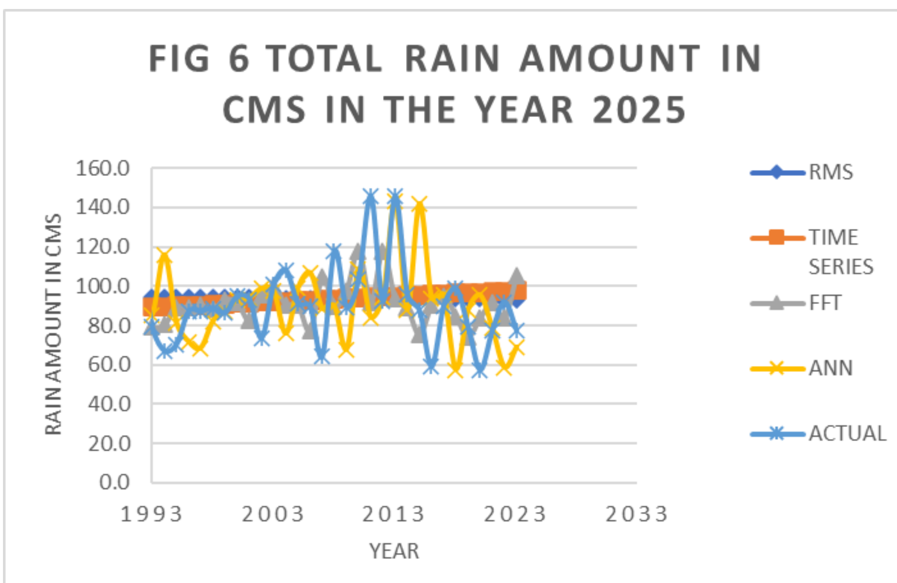
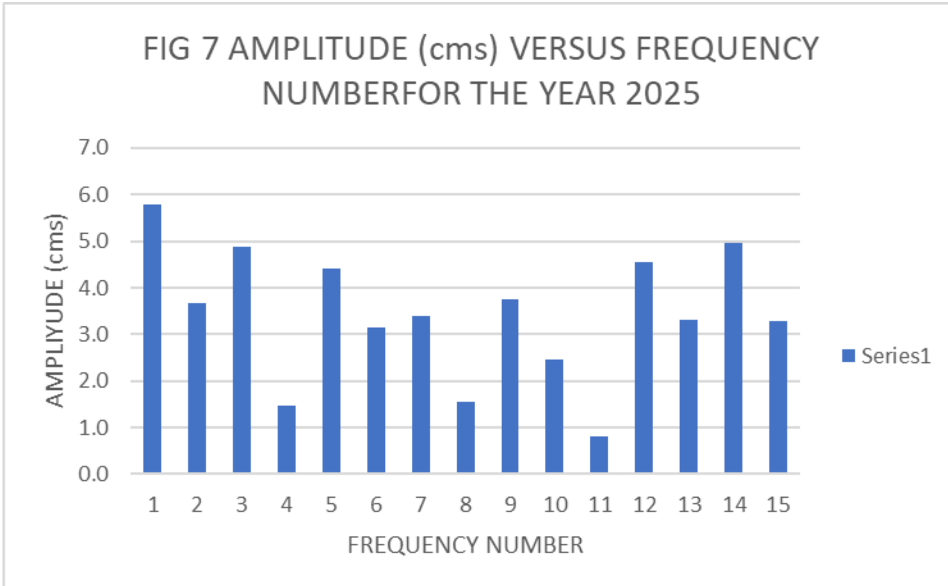


FIG 6 TOTAL RAIN AMOUNT IN CMS IN THE YEAR 2025
RAIN AMOUNT IN CMS
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1993
2003
2013
2023
2033
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL



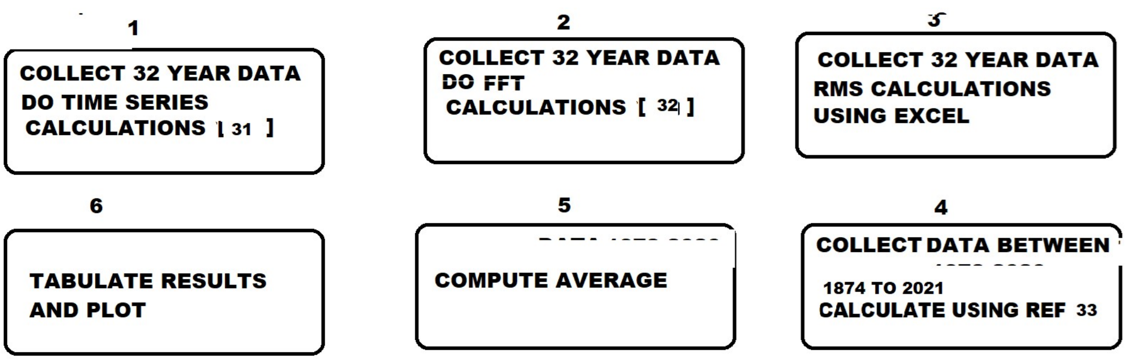


FIG. 8 NUMBERED BLOCK DIAGRAM OF THE COMPUTATIONS