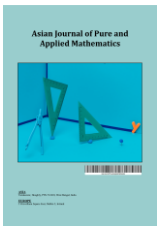

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Monsoon Rain Amount for Marathawada in the Year 2024

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Abstract

Marathawada has problems with rain all the time. Crop failures are very frequent. This poses serious problems to the farmers because they borrow money at a high interest rate from the banks or from private money lenders. Due to the uncertainty of the rainfall, they have difficulty in planning for the planting of crops.

To reduce the uncertainty- this research has been taken up where several methods are used to predict the rainfall. 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. The advantage of using these four methods is that the calculations can be done about seven months in advance to give sufficient time to the farmers for planning. The methods involve extensive computations detailed in references 46 to 48. Here, the data available or the past rain records are used to make prediction for the coming year. In the Time Series method – each of the monsoon months -June, July, August, and September are considered as separate season of the given year and overall regression line is arrived at. On the other hand, in the RMS – the regression line for each of the methods is found and then the projection is made for the coming year.

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In the Fast Fourier Transform method, the Fourier series curve for each of the months is arrived at by computing its coefficients using a faster algorithm which is normally very computation intensive. From this series, a trend is computed and then the projection is made.
In the Neural Network method, which these days are also called Artificial Intelligence method – the network is trained first using the existing data and then based on this training which is essentially to compute the weight matrix due to this training. After computing the weight matrix, baseed on the input of the existing rain record, the rain amount for the coming year is calculated.

Keywords: Monsoon rain prediction; annual rainfall; rainfall frequency spectrum; flood control; hydropower generation.

1 Introduction

1.1 Water shortage in many Maharashtra regions

The deficient rain in this region can be seen in [1-12]. It must be emphasized that the shortage of water or the lack of rainfall causes the administration to transport water by rail and truck [13-18].

The location of Marattawada is shown in Fig. 1. The monsoon arrives in this area from the southwest direction and there are mountain ranges in its path before it reaches Marathawada. This area is in the shadow of the mountain range. Shortage of water in this area can also be seen in [19-22]]. One also has to remember a fact that sugar cane is planted here which requires large amount of water. This place is not suited for sugar cane crops due to this heavy amount of water requirement. Planting of sugar cane crop results in crop failures for many other farmers and many of them commit suicide when their crop fails.

Fig. 1. Locations of Marathawada Vidarbha and Telangana between Western and Eastern Ghats

India is facing mass migration from the rural areas to the suburbs where the land prices are shooting high [23-25]. Therefore, there is a demand for housing as a result -there is large construction of apartment buildings. Many times, these buildings have been built on lakes and ponds which used to store water. The larger population in the cities increases the demand for water and this results in lowering of the water table. This lowering of the water table also causes hardship to the farmers who many times irrigate their fields with pumps. Water from canals and underground water account for irrigation of about 35 percent of the crop planted area. The balance of the area is dependent entirely on rainwater.

In India, the availability of water comes from mainly the monsoon rain and the amount is roughly from 75 to 90 percent. The remaining water comes from rivers or that stored in lakes and ponds.

The financial condition of the farmer becomes precarious because they have to buy seeds and other supplies in cash or credit. The borrowing cost from the moneylenders is high including those from the banks. The crop failure causes this desperation and suicide among the farmers.

In India, it is quite common for the government to impose export restrictions when the domestic price of their produce becomes high. Such restrictions are not there on industrial goods. This happens in a very abrupt manner. In this way the farmers are prevented from reaping benefits of higher prices.

As stated before, there are four sources of water for any use. These sources are- (a) stored water in ponds, and lakes, (b) those in flowing rivers (c) in form of snow or ice on the Himalayas, and (d) as ground water. In case of deficient rainfall, the only option for most farmers is to get to the underground water whose level is getting lower and lower.

The others who need water are people living in the cities or villages, hydropower generators, many industries [26-39].

2 Methods

In this present research the data used is for last 32 years. In the ANN method one needs data going back to 1876. This length of data is needed for training the network involved in this method.

This study where the prediction is made about seven months ahead of time is also useful in flood control because when the heavy rain takes place - all the rivers and their tributaries in a particular river basin get flooded. Consequently, the dams start overflowing. This compels the management to open up the gates of the barrages thereby flooding the areas downstream.

Many other researchers have been publishing their work which can be seen in [40-45].

3 Results and Discussion

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.

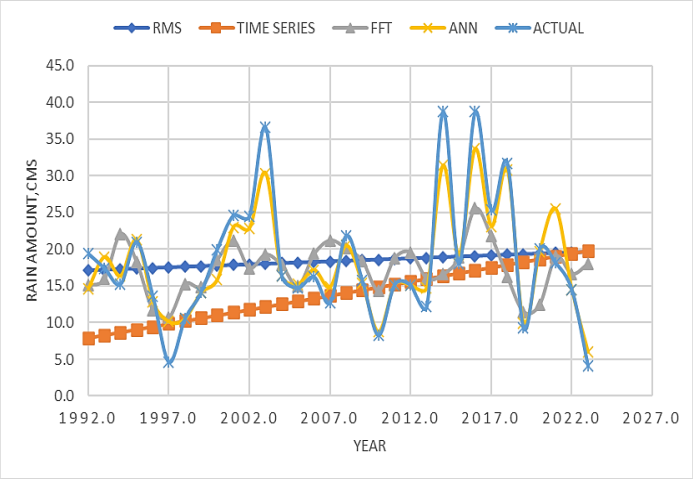

Fig. 2. Rain amount (cms) in the month of june 2024

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

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

In the Time Series method, each of the months starting from June to September is considered as separate season [46]**.** Then based on the 32-year-old data - an overall trend for all these seasons is calculated. Based on this trend, they predicted value for this method for the year 2024 is computed.

In the Fast Fourier method, Fourier coefficients are calculated and then used for calculations for the time span of 32 years. The coefficients are determined using a faster algorithm. Once the coefficients are known then the function is synthesized and extended to the year 2024.One can read the details about this in [47].

In the ANN method, 32-year data from the year 1876 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 187**6** by the next record which will be year 187**7.** Consequently, the output vector becomes the 34th year from the year **1**87**6.** In this way, the final output vector will be the year **20**23**.** After training the network this way, the prediction is made using the trained weights for the year 202**4.** The details about this method can be seen in [48]. The equation relating the input vector {I} and the output vector {0} is given by

$$\{o\} = [W]\ \{I\} \tag{1}$$

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

The results in Figs. 2 to 6 show separately the 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.
In Fig. 2, these Time Series values, and the RMS values exhibit straight line relationships due to linear regression analysis and both of these methods show increasing trend. The actual rainfall values fluctuate at the high rate.

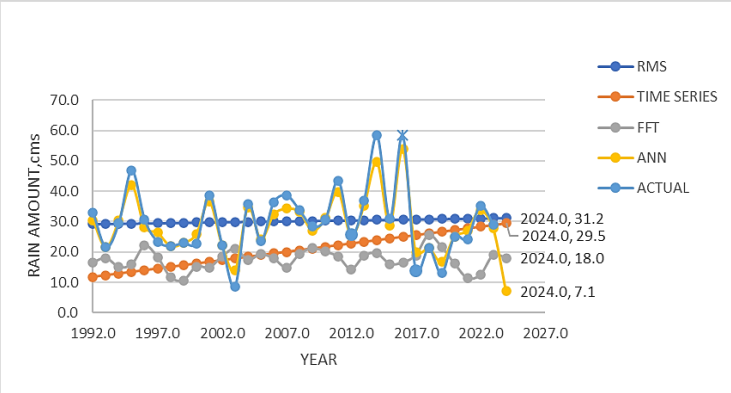

Fig. 3. Rain amount for july for Marathawada 2024

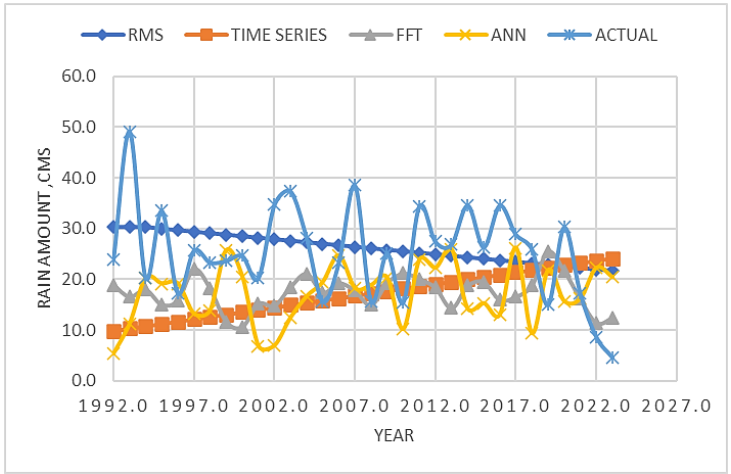

Fig. 4. Rain amount in august 2024

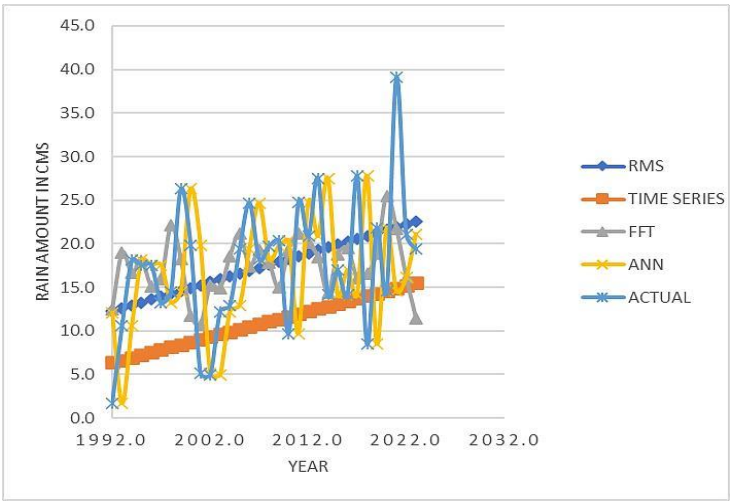

Fig. 5. Rain amount in september 2024

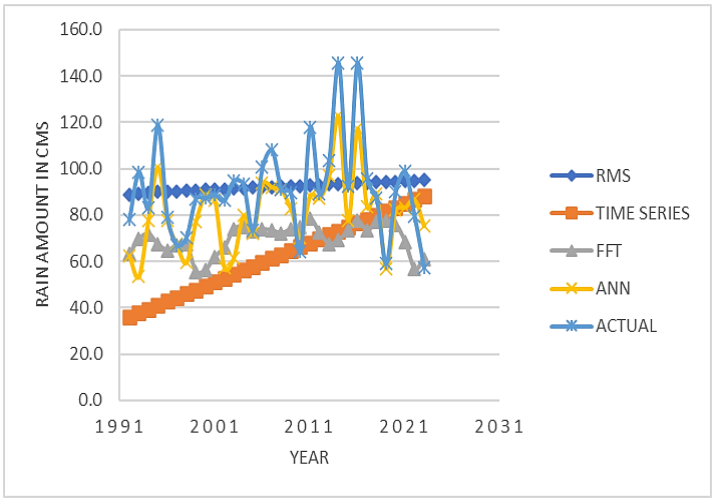

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Fig. 6. Total rain amount in cms in the year 2023

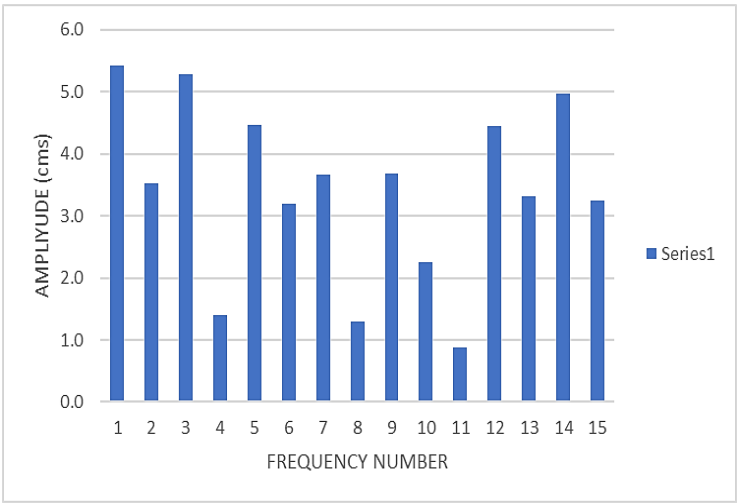

Fig. 7. Amplitude (cms) versus frequency number

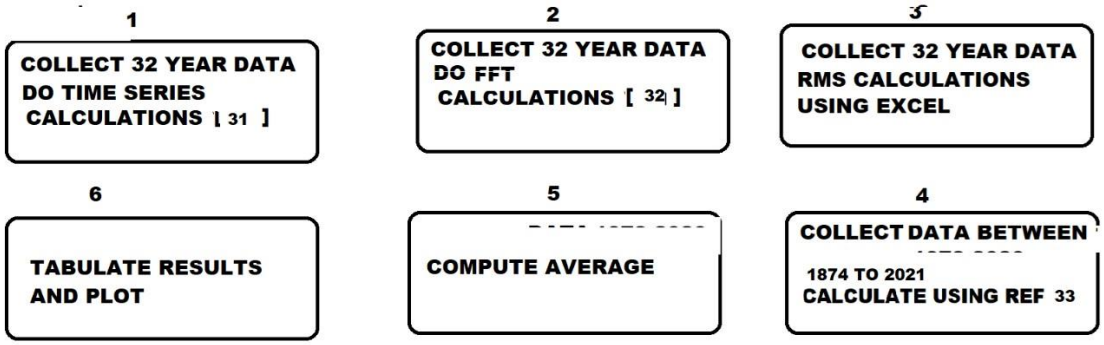

Fig. 8. NUMBERED BLOCK DIAGRAM OF THE COMPUTATIONS

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 FFT method results also vary similar to the actual rainfall values but the fluctuations or the magnitude of fluctuation is not as much as that of the actual values.

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.

In Fig. 6, the time series method has very high positive slope whereas the RMS method has a low value of its slope. The actual rainfall values also change very rapidly as before in Fig 6.

The summary of results is shown in the Table 1. This table shows that the predicted rainfall value for the year 2024 is less than the 32-year average.
Fig. 7 shows the frequency diagram of the rainfall for the last 32 years. One thing to note in this figure is that the frequency numbers 4, 8, and 11 have low magnitudes respectively. The high magnitudes of higher frequencies indicates that there is very rapid change in the actual total rainfall value.

Fig. 8 shows the details of the computations. Here, each block has been numbered to make the sequence of computations clearer.

Table 1. Rain forecast in centimeters for marathawada during 2024 monsoon months

Method	Year	June	July	August	September	Total	Comments
Time Series	2024	20.1	29.5	24.7	15.8	90.1	
FFT	2024	15.6	18.0	20.4	15.2	69.2	
ANN	2024	16.5	7.1	25.3	19.4	68.3	
RMS	2024	19.7	31.2	21.3	22.9	95.2	
Predicted Value	2024	18.0	21.5	22.9	18.3	80.7	Rain Below 32-Year Average
32-Year Average		18.4	30.2	25.4	17.4	91.3	

4 Conclusion

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 2024.
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. Since this area is always short of rainfall, therefore, it is not suitable for planting of sugar cane due to high water requirements. This prevents other needy farmers from the water availability, and which results in many of the farmers suicides.

Competing Interests

Author has declared that no competing interests exist.

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