Marathawada Rain Amount Forecasting During the Monsoon Months of the Year 2022

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Abstract— **From historical studies, it is well known that Marathawada is a rain deficient region and has been a cause of farmer's suicides. In such situations, forecasting for rain amount is quite helpful in planning for crop plantation well in advance. In this work, the prediction is based on the use of four methods which 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. Since these methods are numerical, the accuracy of any of these methods taken separately is not reliable. Therefore, the predicted value is taken as the average of four values obtained by these different methods. The average value this year will be slightly above the average of last 32 years.**

Index Terms— **Monsoon rain prediction, Annual rainfall, Rainfall frequency spectrum, Flood control, Hydro-power generation.**

I. WATER SHORTAGE IN MANY MAHARASHTRA REGIONS

Marathawada is known to be water deficient area in Western India and this area is shown in Fig. 1. It is unfortunate that no answer to this problem has been found so far [1-4]. Sugarcane is one of the crops planted in this area but it requires large amount of water. The result is that many farmers do not get their fair share of water for planting other crops as a result of sugarcane planting. This imbalance results in worsening of the financial condition of the farmers.

In India, there is large scale encroachment of water bodies in the cities and it has caused water table to drop far below the ground surface. The cause of this encroachment is the higher return on investment in the area of construction of real estate. The builders, see higher returns in constructing high-rise buildings with flats. This encroachment of water bodies causes water shortage in cities and surrounding areas. Information about such shortages can be seen in [5-7].

Water from canals and underground water account for irrigation of about 40 percent of the crop planted area. The balance of the area is dependent entirely on rain water. In India about 75 to 90% of rainfall takes place during June to September period. The rising population has led to increase in demand for water. To fulfil this need - more and more pumps are being installed. In addition, there is increased rate of migration of population from rural to urban areas. This has led to the over-burdening of load on city water supply.

One also needs to understand the risk of a farmer in case if the crop fails. The farmer borrows money for seeds and other supplies and pays in cash. However, if the crop fails then the others involved in this chain do not incur losses because of the cash sale. Not only this, if there is a bumper crop then the price per unit weight of the produce falls due to the lack of corresponding demand. There are restrictions imposed by the governments on food grain export. Such restrictions are not there on industrial goods. The subsidies of the governments to a farmer is not as much as those living in industrially advanced countries. In those countries, agriculture is heavily subsidized.

There are four sources of water - (a) stored water in ponds, and lakes, (b) those in flowing rivers plus (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.

Water is needed in many sectors such as in agriculture, daily usage in cities and villages, power generation, as well as in many industrial processes.

The deficient rains have caused farmers suicides [8-12]. Refrences [13-21] also discuss farmer's plight. Even hydro-power generation is affected by lack of rain [22].

Accurate prediction well in advance - will help farmers in planning for planting of crops and avoiding increased risk, should there be a deficient rain...

In this work, the prediction is based on 32- year rainfall history of an area. It is to be noted that the rainfall pattern can change even at a distance of 100 kilometer. Therefore, it is advisable to carry out studies on areas which are closely spaced.

These studies are also helpful in planning of hydro-electric power generation because the expected rainfall is predicted about 7 months in advance.

The results of this research can also be used in planning for dangers of flood. This is because dams have been built on rivers and their tributaries. If there is heavy rain over the catchment area then large amount of water will be released all of a sudden when the dams start overflowing. The simultaneous release of water from many dams cause floods in areas downstream.

One can also refer to the works of many researchers who have

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carried out studies on rainfall [23-30].

II. ANALYSIS OF HISTORICAL DATA AND RAIN AMOUNT PREDICTIONS

This work involved calculations using four methods which (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 needs to calculate the mean of the square root value based on linear regression analysis for each of the months separately over time history of 32 years. The computations are quite extensive and the details of various steps involved are shown in Fig. 8.

In the Time Series method, the rainfall amount in each of the monsoon months – June, July, August, and September require separate computations as separate periods[31]. Then the overall trend is calculated for 32 year data using linear regression analysis. In calculations, the average departure of the rain for each of the months is calculated. Here, the overall trend is used

In the Fast Fourier method, the history of the rainfall is approximated using Fourier series whose coefficients are obtained using a faster algorithm. One can read the details about this in [32]. Based on the history and considering the trend – rain amount in the year 2022 is predicted.

In the ANN method, 32 year data from the year 1874 are used as the input vector and the rain amount in the 33rd 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 1874 by the next record which will be year 1875. Consequently, the outputput vector becomes the 34th year from the year 1874. In this way, the final output vector will be the year 2021. After training the network this way, the prediction is made using the trained weights for the year 2022. The details about this method can be seen in [33].

Table 1 shows the summary of all the results. The actual rain history and the results obtained by various methods are shown in Figs 2 to 7.

Calculated results are plotted month-wise for the months of June to September in Figs 2 to 5 respectively. Fig. 6, shows the total values of results.

In Fig. 2, the Time Series and Root Mean Square values have straight line variation due to the linear regression. The actual rainfall shows values which change abruptly from year to year. The RMS vales represent very closely all the points. The ANN values show high fluctuations The Time Series values remain at higher levels as compared to those of other methods.

Fig. 3 shows the rainfall for the month of July. Here the trend is higher with years. Here the fluctuations in the actual rain are far more than in any other values using different methods. Again the actual rainfall changes abruptly from year to year.

In Fig. 4 shows the overall a decreasing trend. The actual values fluctuate from one year to another.

The rainfall history for September is shown in Fig. 5. It shows the increasing trend. The amount of rainfall in this month is less than those of months of July and August. Abruptness is there in the actual rain and in ANN values.

In Fig. 6, the actual rainfall values of different months were added up as total rain. Here, there is overall not much difference in various method results - i.e. all yield closer final values for the year 2022. The FFT values also show sharp changes.The final values in Fig 6 are shown in the Table 1.

Fig. 7 is a plot of amplitudes versus frequency numbers based on the results of Fourier analysis. Here, we see that frequency numbers 1, 3, 13, and 14 have significant amplitudes. All of the amplitudes have been calculated using the Fourier series. The rapid variation of total rainfall from year to year is due to the presence of many significant higher frequencies such as 13 and 14...

CONCLUSIONS

In this work sources of water were discussed and the deficit of amount of water in this area was discussed. It was pointed out that – among different people who are involved in agriculture, it is a farmer who ends up taking most of the risk in case of crop failure.

Lack of rain very badly affects the hydro-power generation and water supply to the people in the cities.

Based on this work one can conclude the following:

1. The historical rain data and the results of the present work show that this year there will be slight increase in rainfall as compared to the average of last 32 years.
2. The presence of several significant frequencies in the rain spectrum - cause rapid change in the total rainfall.
3. Among the crops, planting of sugarcane creates imbalance in water availability to other farmers who plant food-grain or other crops. .

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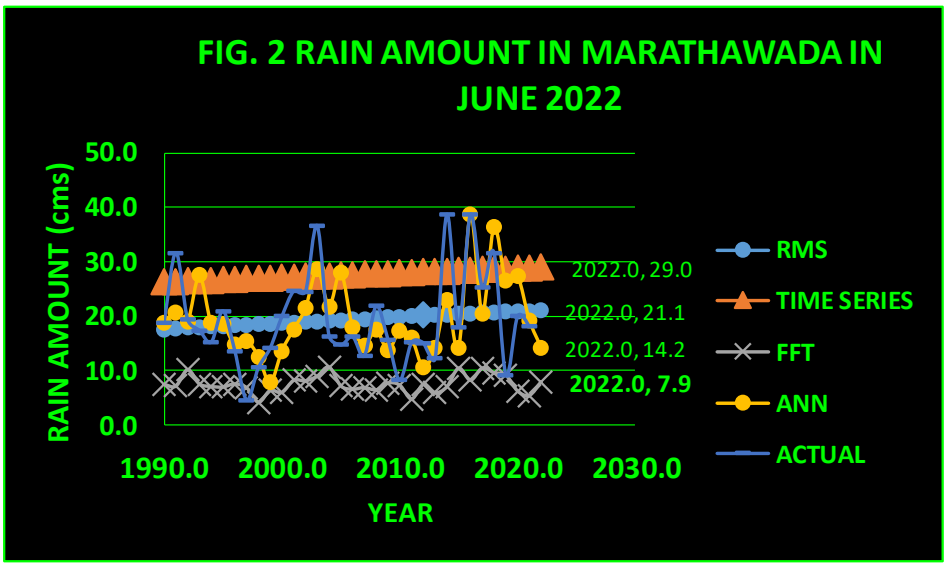
TABLE 1: RAIN FORECAST IN CENTIMETERS FOR MARATHAWADA DURING 2022 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
FFT	2022	7.9	37.0	37.0	21.2	104.4	
TIME SERIES	2022	29.0	27.2	27.7	16.2	100.2	
ANN	2022	14.2	27.5	26.0	17.4	85.1	
RMS	2022	21.1	31.1	23.8	24.5	100.5	
PREDICTED - AVERAGE OF ABOVE	2022	18.1	30.7	28.6	19.8	97.6	Slightly above the 32 Year Average Value
32 YEAR AVERAGE		19.4	29.7	27.4	17.0	93.5	

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



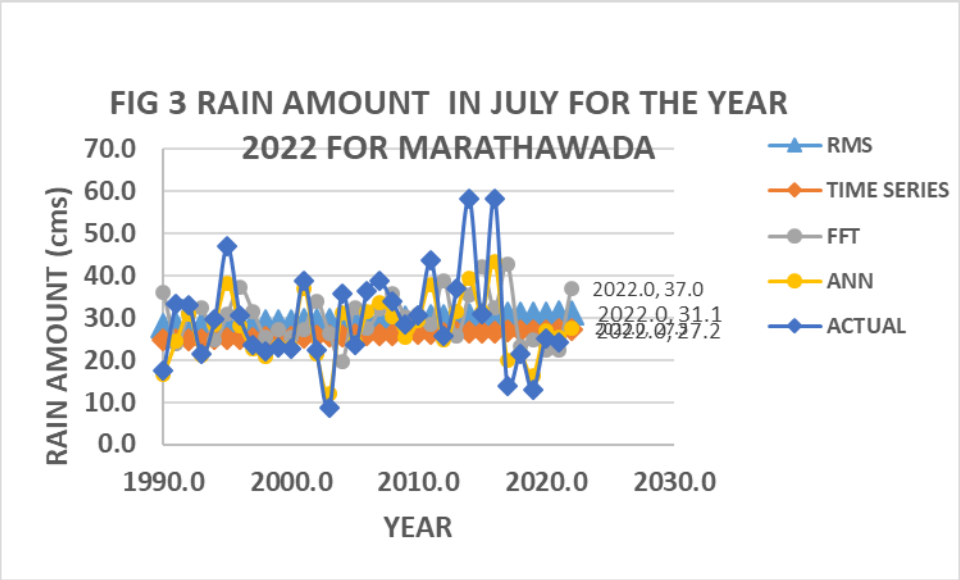


FIG 3 RAIN AMOUNT IN JULY FOR THE YEAR 2022 FOR MARATHAWADA
RAIN AMOUNT (cms)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990.0
2000.0
2010.0
2020.0
2030.0
YEAR
2022.0, 37.0
2022.0, 31.1
2022.0, 27.2
RMS
TIME SERIES
FFT
ANN
ACTUAL

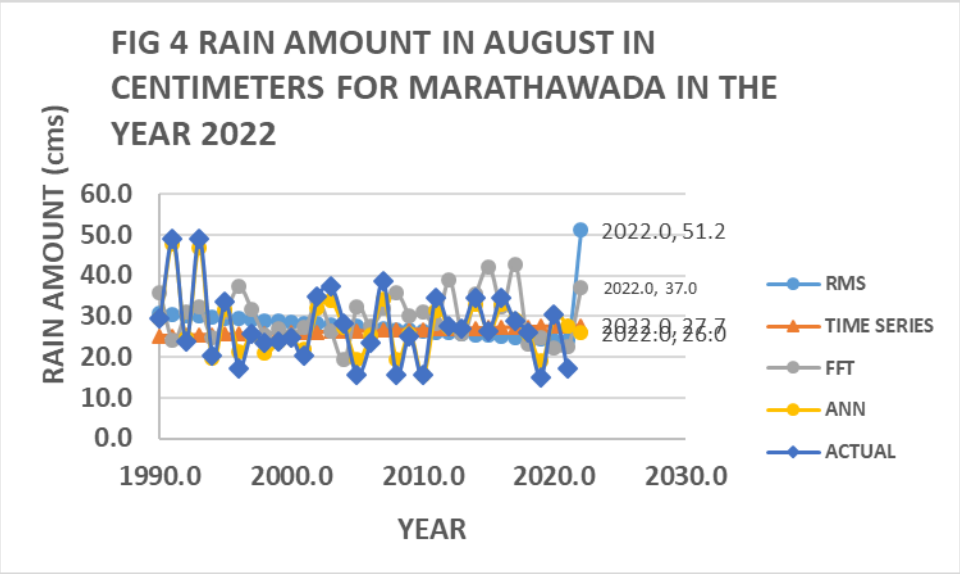


FIG 4 RAIN AMOUNT IN AUGUST IN CENTIMETERS FOR MARATHAWADA IN THE YEAR 2022
RAIN AMOUNT (cms)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990.0
2000.0
2010.0
2020.0
2030.0
YEAR
2022.0, 51.2
2022.0, 37.0
2022.0, 26.0
RMS
TIME SERIES
FFT
ANN
ACTUAL

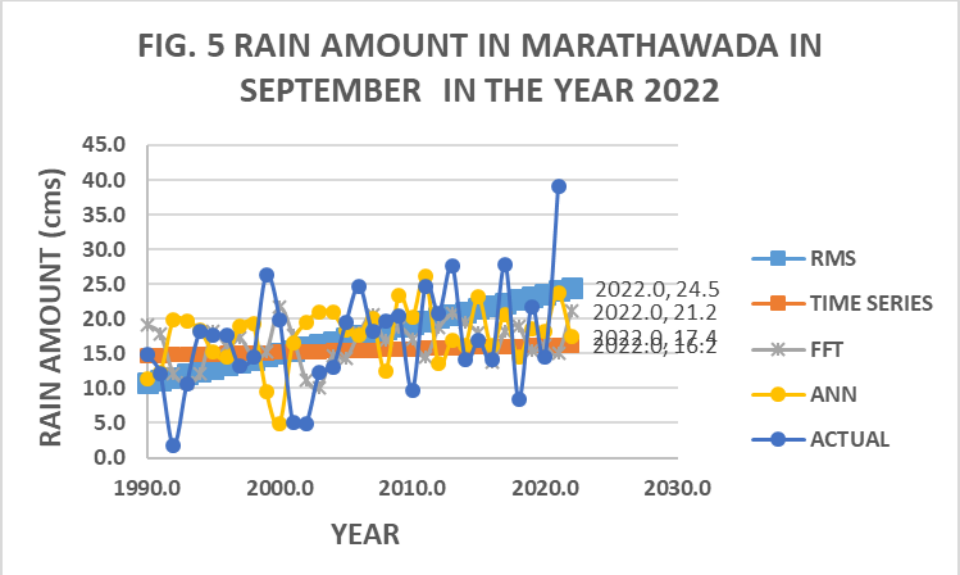
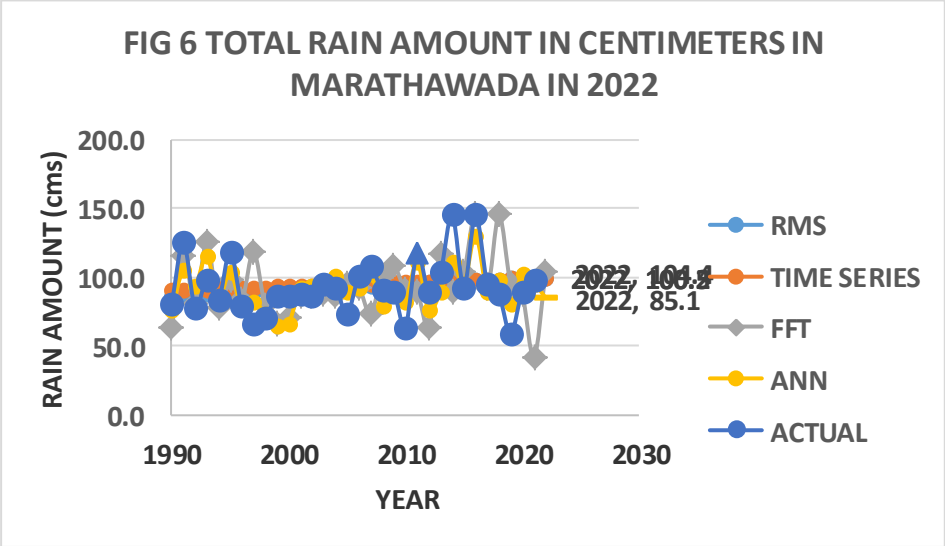
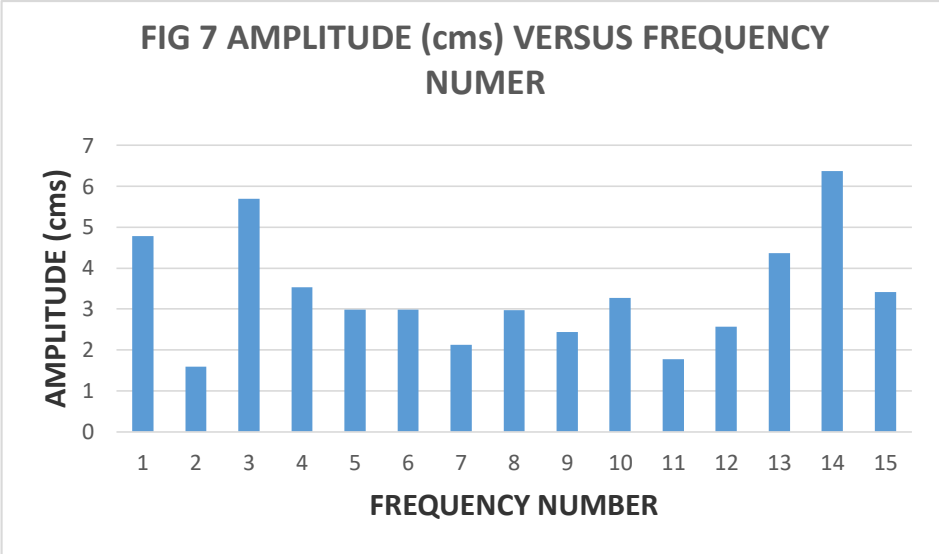


FIG. 5 RAIN AMOUNT IN MARATHAWADA IN SEPTEMBER IN THE YEAR 2022
RAIN AMOUNT (cms)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1990.0
2000.0
2010.0
2020.0
2030.0
YEAR
2022.0, 24.5
2022.0, 21.2
2022.0, 16.2
RMS
TIME SERIES
FFT
ANN
ACTUAL





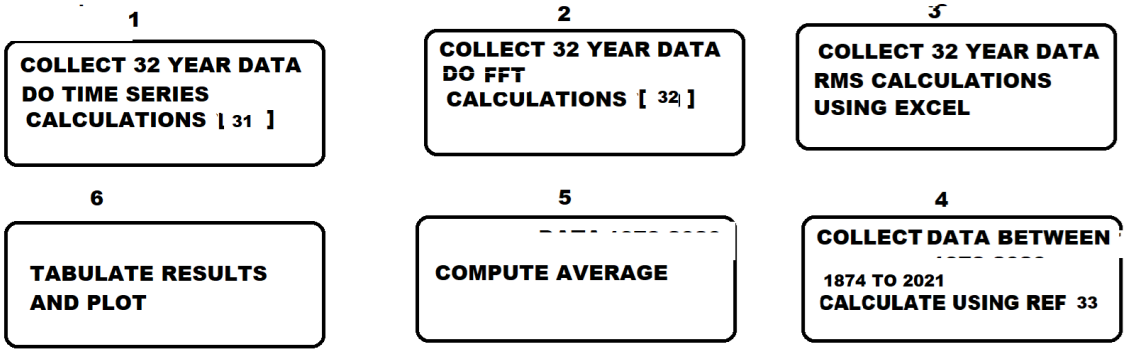


FIG. 8 NUMBERED BLOCK DIAGRAM OF THE COMPUTATIONS