Prediction of Monsoon Rain Amount in Jharkhand in the Year 2020

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Abstract— **Of all the water consumed in India, about 75 to 90% of this comes from annual rainfall in the monsoon period. If there is any shortfall in the rainfall during the monsoon period then, one has to plan ahead of time how to act in this situation of water scarcity. Prediction of rain amount well in advance will help in planning to meet the need.**

As a result of this, a period of 32 years is selected for future prediction - about 8 months ahead of time. To attain this objective, the estimate of rainfall amount is made using four methods, which are: (1) Artificial Neural Network (ANN) method, (2) Fast Fourier Transform (FFT) method, (3) the Time Series method, and (4) the Root Mean Square (RMS) method using linear regression. The amount predicted equals the average of results obtained by these four methods.

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

Serious water shortages are caused by continuous lack of rainfall during the monsoon seasons. For example, Chennai in Tamil Nadu state had lack of rainfall for 200 days during the year 2018. This caused heavy shortage of water there. Similarly, all across India there are several places where it did not rain enough in the year 2019. Jharkhand is one among these places where the rainfall was short in the year 2019. In this year Jharkhand suffered 35% shortage until July. Because this state is hilly, therefore distributing water from a reservoir becomes a difficult task. In addition due to the land being rocky also, it makes the task of drilling wells or drawing water from the tube wells a challenging task [1-3].

Due to shortage of rain, people of Jharkhand have had to go through hard times, as agriculture is the mainstay of large population. In India, about 60 per cent of agriculture is rain-fed and a delayed and deficient monsoon means lower agricultural output. This affects the corporate India, as rural consumption or the demand of corporate manufactured products is decreased. This causes problems in the budgets of governments at different levels of the [4].

Difficult times arise when a country's water reserve becomes below 1,000 cubic meters per person per year; the country then faces water shortage [5]. About 700 million people in 43 countries were living below the 1,700 cubic meters per person threshold. Water stress has increased in regions such as China, India, and Sub-Saharan Africa, which has the largest population of the world.

Recently, the state of California in United States of America (USA) went through a six-year drought period. As a result of this, the hydroelectric power stations had to be stopped many times.

The effect of rainfall deficit on fields such as agriculture, city supply, and hydropower has been discussed in [7]. It is worth mentioning here that a lack of rainfall creates havoc in lifestyle as this place is always short of water.

It should be noted that Jharkhand is one area where rainfall is sufficient in many years but it surely lacks water management due to the shortage of reservoirs.

These days, quite often many dams become dry or have low levels in the reservoirs which results in shutting down of the power generation. It is quite common to see the power generation decrease in summer months due to lower availability of water [8-9]. Many other areas of India also have been feeling extreme water shortages [10-26]. Lack of rain also affects hydropower generation is discussed in [27].

Regarding the studies on monsoon rains one can refer to the work of various other researchers [28-36]. Moreover, the rainfall predictions by Indian Meteorological Department (IMD) can be seen in [37].

The physical map of Jharkhand is shown in Fig. 1. It is essentially a hilly area and water due to insufficient storage capacity - flows out into rivers. Even with normal rain, water is lost and shortage is felt soon after the monsoon season

The present study has been undertaken to improve the forecasting regarding the availability of water for hydroelectric power generation as well as for agriculture, city supply and hydropower generation.

II. RESULTS AND DISCUSSIONS

Fig. 2 shows the results of calculations using 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 [38-40]. The actual rainfall varies very rapidly and the variations are very wide. The Time Series and the RMS curve involved linear regression and are straight lines almost along

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the mean value of this actual rainfall record. The other two method results vary about the Time Series results. The Table 1 shows the summary of results for all the months including the total values. The predicted amount value is the average of results obtained by these four methods.

In Fig. 3, the actual results vary over wide range unlike results obtained by the Time Series method and the RMS methods. The ANN method results also vary over high range as compared to the Time Series method.

In Fig. 4, difference between the Time Series method and other results are narrower.

In Fig. 5, there is a difference between the results of the Time Series method and the RMS method where the actual rain amount varies widely along the time. However, the results of all methods approach a closer value as the time approaches the Year 2020.

The total value of rain is shown in Fig. 6. In this figure, the Time Series results are higher than the RMS method; the actual curve shows wide fluctuation, and the FFT curve is lower than the RMS values. The ANN method results are not far off from the RMS values.

The Fig. 7 shows the amplitude versus frequency number plot. Here, frequency numbers 1, 6, 8, and 10 are significant frequencies having amplitudes greater than 5 cm, quite high. This is the reason the rainfall in this year will be quite significant. This means that this year we will end up with sufficient amount of water.

The Table 1 except for the month of September, the rainfall will be close to the 32 year average. Only in September it will rain slightly higher than the 32 year average. This will result in about 5.6% excess rain over the average of 32 years.

III. Conclusion

In this work, the calculations of the rainfall were carried out using ANN method, the Time Series method, the FFT method, and the RMS method. The Time Series method, and the RMS method show a uniform variation in all calculations. The FFT and the ANN methods results show fluctuations but not as much as those in the case of of the actual rainfall.

Based on this study one can conclude the following:

1. The actual rainfall pattern is complicated and difficult to reproduce.
2. The Time Series method, and the RMS method results are linear as a result of linear regression used to determine the curves.
3. The FFT method results are approximations of the actual curve using harmonic functions.
4. Overall, considering all the methods the results obtained are close to the actual values as shown in Table 1.

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TABLE 1: RAIN FORECAST IN CENTIMETERS FOR JHARKHAND DURING 2020 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
RMS	2020	19.5	34.7	27.3	20.8	102.3	
TIME SERIES	2020	20.3	28.1	30.1	16.9	95.4	
FFT	2020	20.4	28.5	26.8	24.2	99.9	
ANN	2020	18.2	32.1	28.2	22.0	100.5	5.6 % GREATER THAN 32 YEAR AVERAGE
PREDICTED AVERAGE	2020	19.6	30.8	28.1	22.0	100.5	
32 YEAR AVERAGE	2020	19.1	30.5	28.5	17.1	95.2	

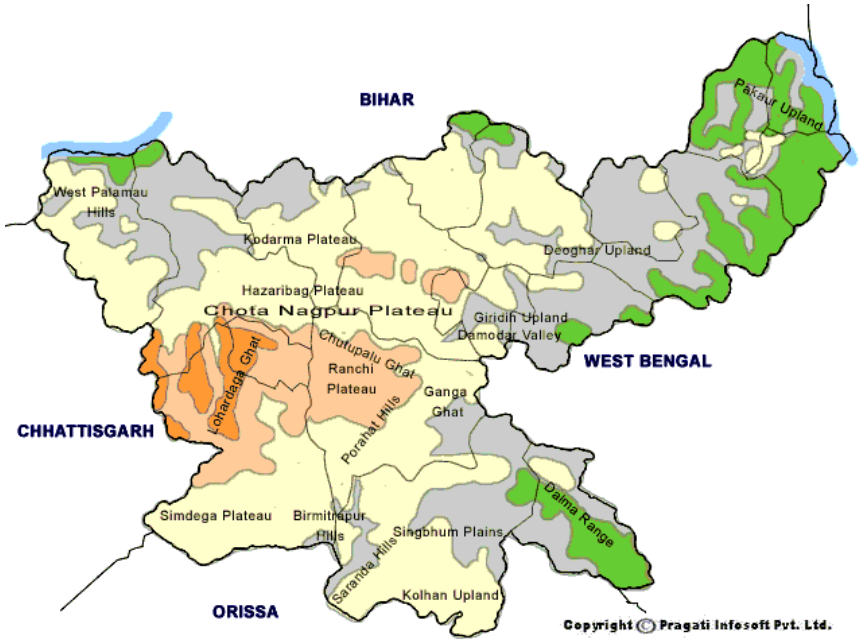
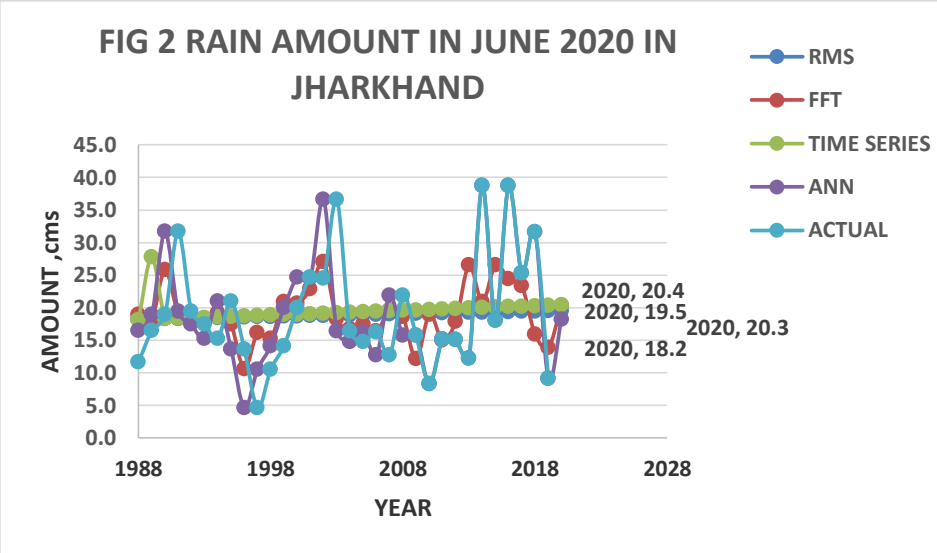
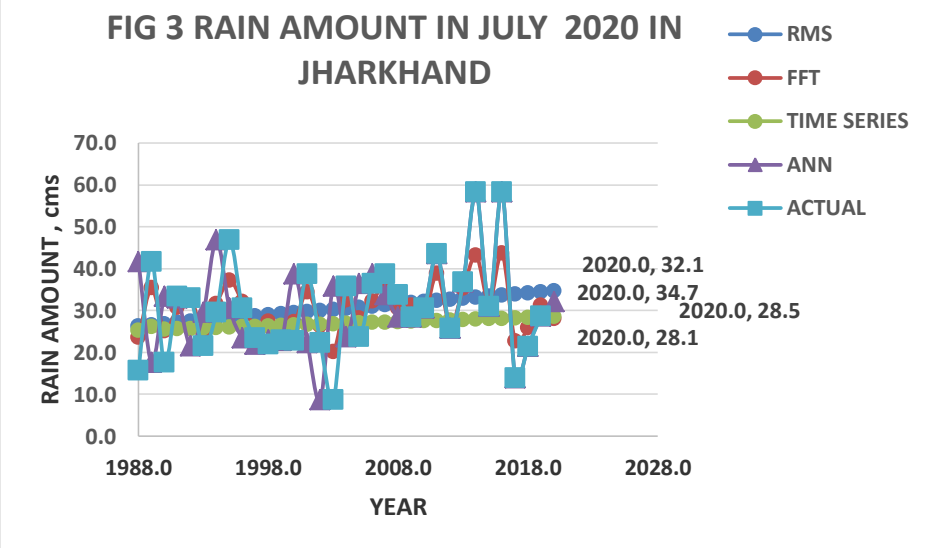


FIG 1 PHYSICAL MAP OF JHARKHAND, INDIA





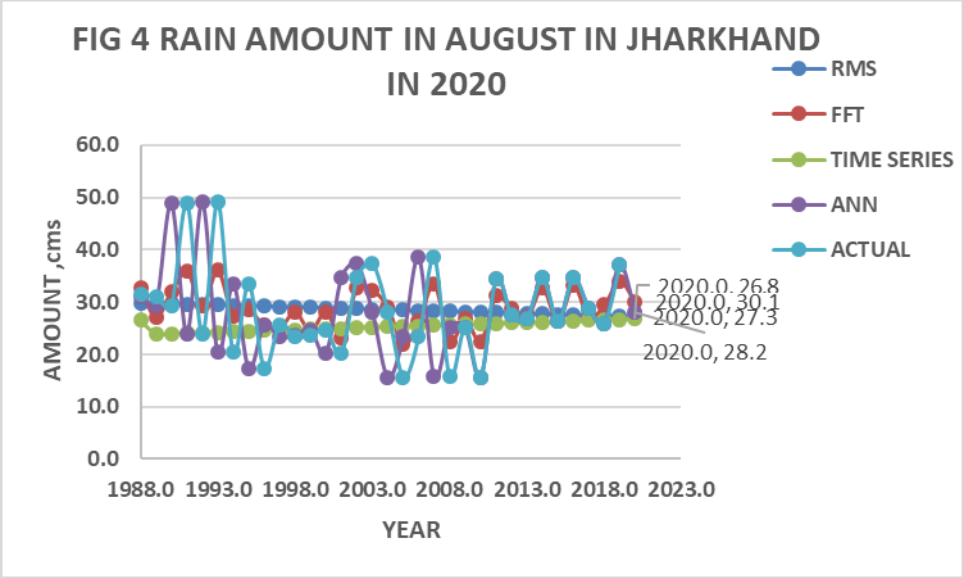


FIG 4 RAIN AMOUNT IN AUGUST IN JHARKHAND IN 2020
RMS
FFT
TIME SERIES
ANN
ACTUAL
AMOUNT ,cms
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1988.0 1993.0 1998.0 2003.0 2008.0 2013.0 2018.0 2023.0
YEAR
2020.0, 26.8
2020.0, 30.1
2020.0, 27.3
2020.0, 28.2

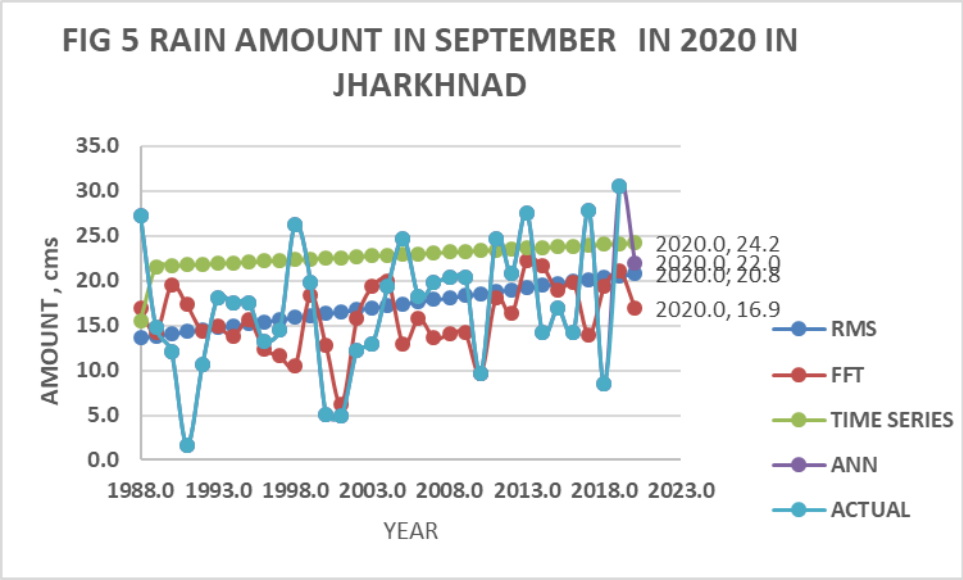


FIG 5 RAIN AMOUNT IN SEPTEMBER IN 2020 IN JHARKHNAD
AMOUNT , cms
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1988.0 1993.0 1998.0 2003.0 2008.0 2013.0 2018.0 2023.0
YEAR
2020.0, 24.2
2020.0, 22.0
2020.0, 20.8
2020.0, 16.9
RMS
FFT
TIME SERIES
ANN
ACTUAL

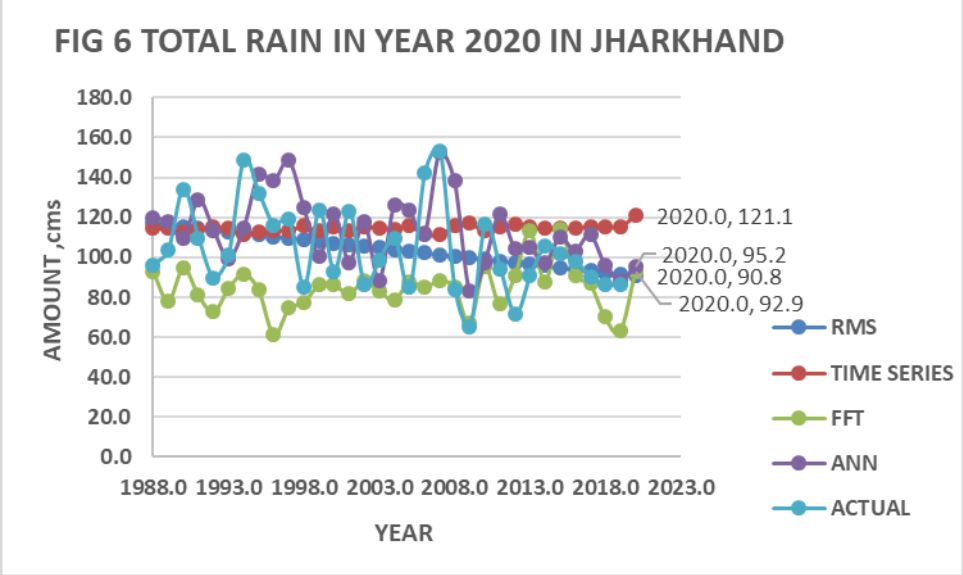


FIG 6 TOTAL RAIN IN YEAR 2020 IN JHARKHAND
AMOUNT ,cms
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1988.0 1993.0 1998.0 2003.0 2008.0 2013.0 2018.0 2023.0
YEAR
2020.0, 121.1
2020.0, 95.2
2020.0, 90.8
2020.0, 92.9
RMS
TIME SERIES
FFT
ANN
ACTUAL