International Journal of Research in Economics and Social Sciences (IJRESS)
Available online at: http://euroasiapub.org
Vol. 8 Issue 4, April - 2018
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

PREDICTION OF RAINFALL IN 2018 IN TELANGANA - AN AREA HAVING ACCUTE WATER SHORTAGES AND CROP FAILURES

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ABSTRACT

In this work the prediction of rain is based on (a) average of Time Series method and Fast Fourier Transform method as well as small quantity of randomness factor. In these methods, historical rain data of Vidarbha from 1986 to 2017 are selected for projection. These methods take into account the trends in rain pattern also.

The forecast is being made in month of April before the Monsoon season and it is forecasted that the rainfall will be less than the 32-year average rainfall value. This early forecast can be useful to the farmers for planting crops, and city governments for making arrangements for water shortages during and after the next Monsoon period. They should possibly avoid suicides amongst farmers which primarily take place due to lack of advance knowledge about the rain failure or rain shortage.

KEYWORDS: Monsoon rain prediction, annual rainfall, rainfall frequency spectrum, El Nino and La Nina influence on rainfall, drought and famine, crop failure

1. INSUFFICIENT RAIN AND ITS EFFECT ON LIVES OF PEOPLE INCLUDING DEPLETION OF WATER RESERVES

India is a country whose population and living standards both are increasing day by day. This results in pressure on resources such as land, water, materials for day to day living. On the other hand India's per capita income is one of the lowest in the world. To grow more food, more and more areas are coming under cultivation. This increases the demand for more water in a country which has vast areas without having irrigation facilities. Such fields primarily depend upon Monsoon rain which accounts for about 90% of water needs. More and more wells are dug or underground water is being pumped out for this purpose.

India's water reserves exist in form of water in rivers, ponds and reservoirs, snow on the Himalayan Mountains which feed large number of North Indian Rivers, and underground water. NASA's satellite observations have shown vast depletion of underground sources of water and the situation has become alarming. Similar shortages are being felt in other areas of India.

In Maharashtra, they grow sugarcane which requires much more water than the usual crops they used to plant in arid areas. They created large reservoirs and dams which went dry due to lack of rain.

Many farmer suicides have been attributed to crop failure due to poor Monsoon season [1-6].

In many areas drinking water is being sent on trucks because the wells and other reservoirs have become dry [7-17]. This calls for greater allocation of resources for water which includes on research obtaining water for useful purposes.

It need not be emphasized that the rain water that we get is in a pure form and it does not need purification or further processing for most of the use. On the other hand, one would need to process water from reservoirs, rivers, underground water depending on what it is going to be used for. Secondly, the rain water need not be transported over longer distances as it is available in most of the areas. It is just a matter of conserving it when it rains. Indians historically have not placed too much importance on water unlike its Arab neighbors. India gets vast amount of rain water where many other countries are not so lucky. One example is Israel which has made tremendous progress in procuring water from various sources. This country can serve as an example. It has made vast improvement in the area of agriculture where water needs are minimized.

Fig. 1 shows three areas which are located between the Eastern and Western Ghats and as a result the rainfall in these areas is very erratic and lack of rain is a cause of many famers' suicides. The erratic and shortfall in Monsoon rains is because the area lies in the shadow of the path of the South West Monsoon.

The present study has been undertaken to improve the forecasting model for the Monsoon which will help in planning for agriculture and even generation of electrical power (hydro-electricity). These days many dams become dry or have low levels in the reservoirs which causes 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 [17].

Given the reasons above, it is desirable that we come up with a model to predict Monsoon rainfall far in advance. Indian Meteorological Department (IMD) makes predictions so that the farmers, and various governments at different levels, be prepared from before about the amount of rainfall in the Monsoon season (total new water to supplement the reserves). This way, the farmers can decide what to plant and how much to plant? The farmers are usually under heavy loans and the crop failure can drive them towards suicide.

Similarly, in several cases one can have idea about floods also because it is caused by excess rain in a river basin. If the rain is heavy – various dams in this basis get excess water and it has to be released quickly to avoid spill over. If there are several dams in a basin then opening all gates at one time or in quick succession causes floods downstream.

In this respect one can refer to work of some scientists working in this area [18-21]. Moreover, the rainfall predictions by IMD can be seen in [22]

In the present study, the prediction is based on the data of previous year and going back 32 years in total. This data is analyzed using linear regression analysis as well as Fast Fourier Transform methods. Separate studies are done for separate areas as it has been found that in many cases a distance as little as 100 kilometer can lead to entirely different rain pattern.

2. HISTORICAL DATA ANALYSIS AND PREDICTION OF RAINFALL IN COMING MONSOON SEASON.

In Fig. 2 we see that the regression results show constant rain whereas there are wide variations in actual rainfall history. In recent years, the actual rainfall has shown a declining trend. There is wide difference in prediction of the rainfall in the coming season. Table 1 shows the summary of all results for this year. In the prediction, a factor based on randomness is also used where a random number, r, between 0 and 1 is generated and used in the formula:

Predicted Value= Average Value (calculated in Table 1) + (Average Value x 0.2) (r-0.5) (1)

If r is greater than 0.5 then the Predicted Value will be greater than the Average Value otherwise it will be less.

In Fig. 3, one can see an increasing trend from 1986 to the present. The FFT (Fast Fourier Transform method) shows higher values than the actual rain in the earlier part but the results are close in last several years. The linear regression analysis results fairly well represent the actual rain values. The details about these two methods can be seen in [23, 24].

However, when it comes to prediction for the year 2018, both methods yield widely different values. In this table then an average of these two methods is calculated first. For prediction, a set of random numbers, r, between 0 and 1 were generated. These were used in the formula for Predicted Value as shown above.

The reason for use of random numbers is because one can converge towards the expected value due to small amount of randomness beyond the averaging process. However, due to the complexity of the process one cannot approach the expected value deterministically. So, a small amount (20% of the Average Value) is assigned to randomness. For value of r above 0.5, this component is added to the Average Value otherwise it is subtracted.

In Fig. 4, the two methods are yielding closer results. The other details can be seen in Table 1. In Fig. 5, there is a decreasing trend but the two methods are yielding widely different results. Fig. 6 shows very slight decreasing trend.

The picture is clearer in the Table 1 which is a summary of the results. Months of June, July, and August show greater predicted rain than the average of 32 years. However, it is slightly less in September whereas it will be significantly less when overall (sum of all the months) is seen.

These results show that the water availability situation warrants greater allocation of resources from the government and the people. It is pointing towards further depletion of reserves after this Monsoon season. Therefore, the government and people have to remember that the reserves cannot go on decreasing beyond certain limit.

Fig. 7 shows various frequencies that exist in the total rain. Presence of higher frequencies indicate rapid variation in rainfall from one year to another.

3. CONCLUSIONS

1. The rainfall in the month of June to August will be will be slightly above the 32 year average.

2. The rainfalls in other months will be less than the corresponding average values which includes the total value also.

3. These shortages indicate that there has to be conservation of the rain water by digging ponds, wells, and building dams.

4. There is a need to implement agriculture techniques of using less water in agriculture as is in practice in Israel.

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TABLE 1: RAIN FORECAST IN CENTIMETERS FOR TELANGANA DURING 2018 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
TIME SERIES	2018	31.8	29.5	30.4	27.4	104	
FAST FOURIER TRANSFORM (FFT)	2018	17.0.0	41.1	27.5	16.1	80.5	
AVERAGE OF TIME SERIES AND FFT METHODS	2018	24.4	35.3	28.9	21.8	92.3	
PREDICTED AMOUNT	2018	26.4	33.7	31.7	21.4	99.7	Less Than the 32 Year Average Value – 11.038 % less
RANDOM NUMBER r		0.9058	0.2785	0.9706	0.4218	0.0357	
32 YEAR AVERAGE		21.3	33.2	30.6	21.8	106.9	

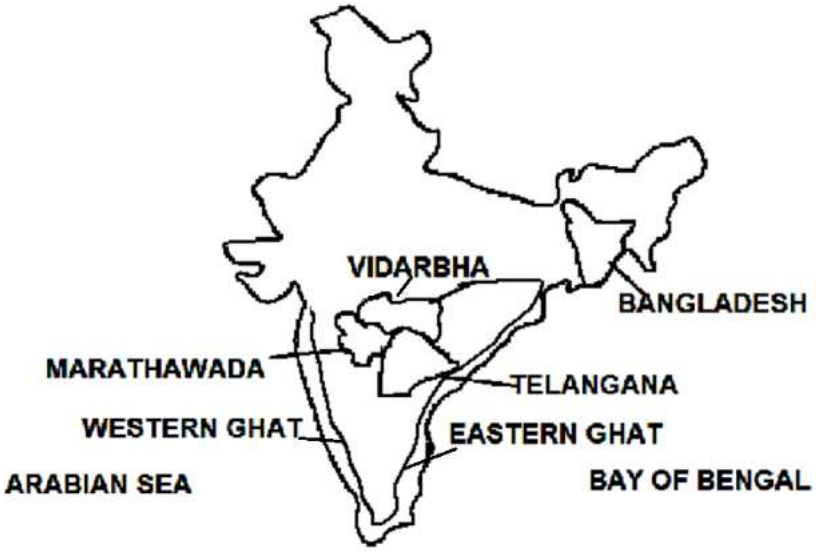


FIG. 1 LOCATIONS OF MARATHAWADA. VIDARBHA. AND TELANGANA BETWEEN WESTERN AND EASTERN GHATS

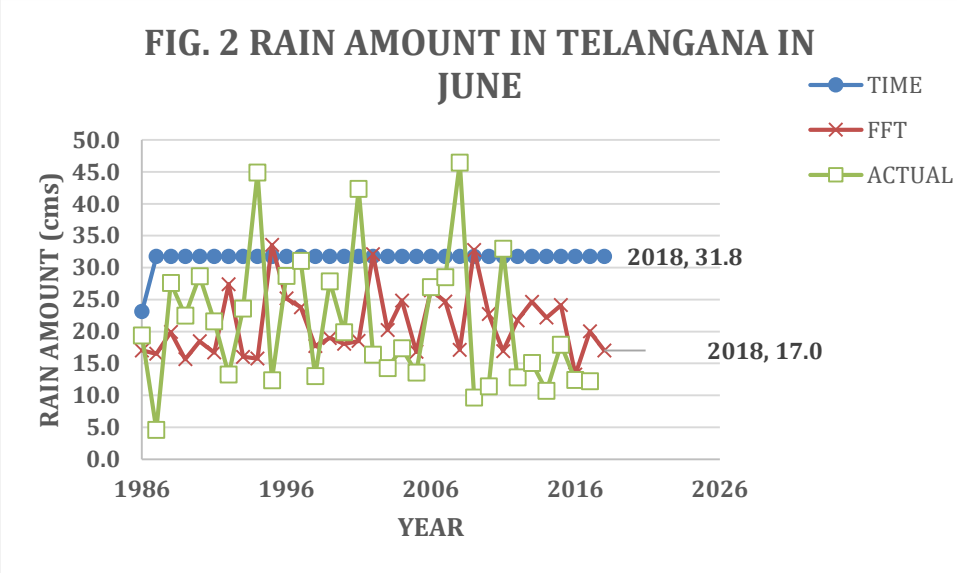


FIG. 2 RAIN AMOUNT IN TELANGANA IN JUNE
TIME
FFT
ACTUAL
RAIN AMOUNT (cms)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1986
1996
2006
2016
2026
YEAR
2018, 31.8
2018, 17.0

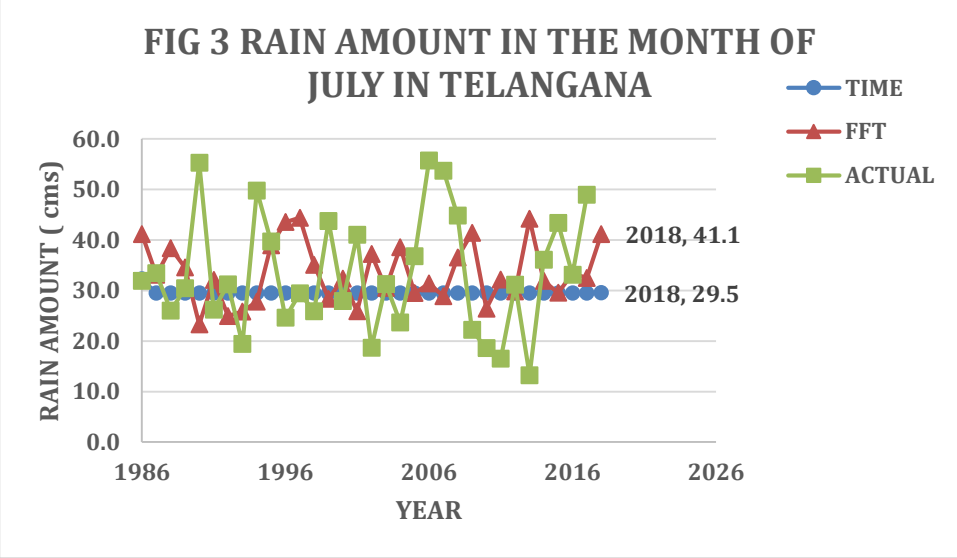


FIG 3 RAIN AMOUNT IN THE MONTH OF JULY IN TELANGANA
TIME
FFT
ACTUAL
RAIN AMOUNT (cms)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1986
1996
2006
2016
2026
YEAR
2018, 41.1
2018, 29.5

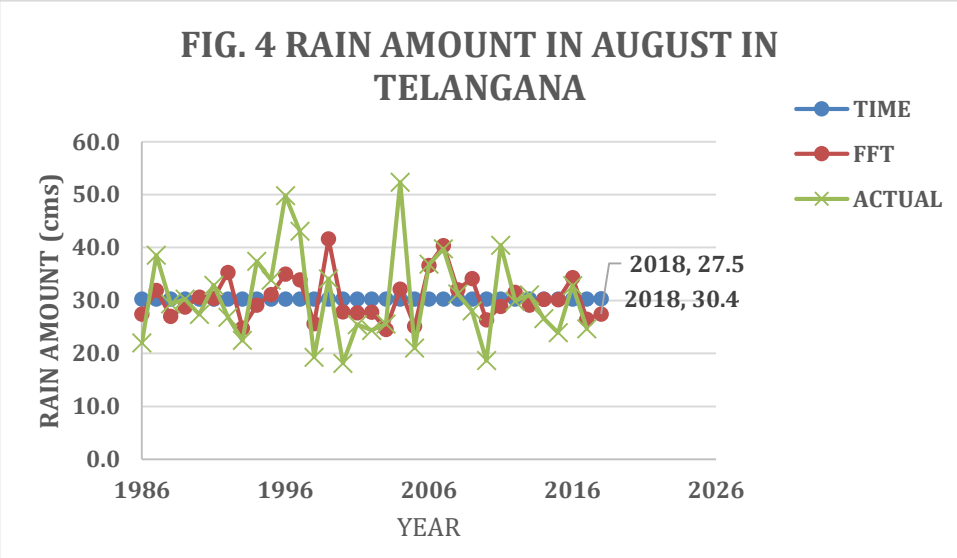
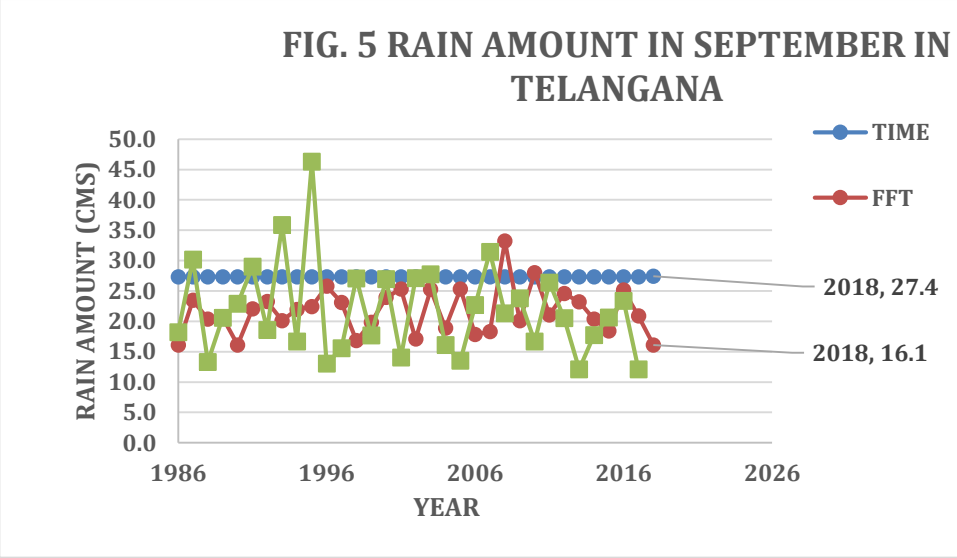
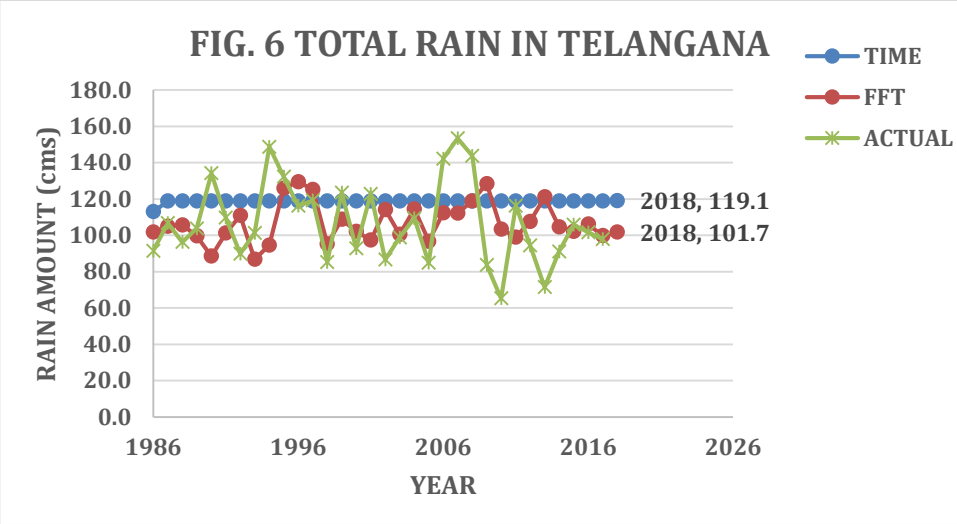


FIG. 4 RAIN AMOUNT IN AUGUST IN TELANGANA
TIME
FFT
ACTUAL
RAIN AMOUNT (cms)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1986
1996
2006
2016
2026
YEAR
2018, 27.5
2018, 30.4





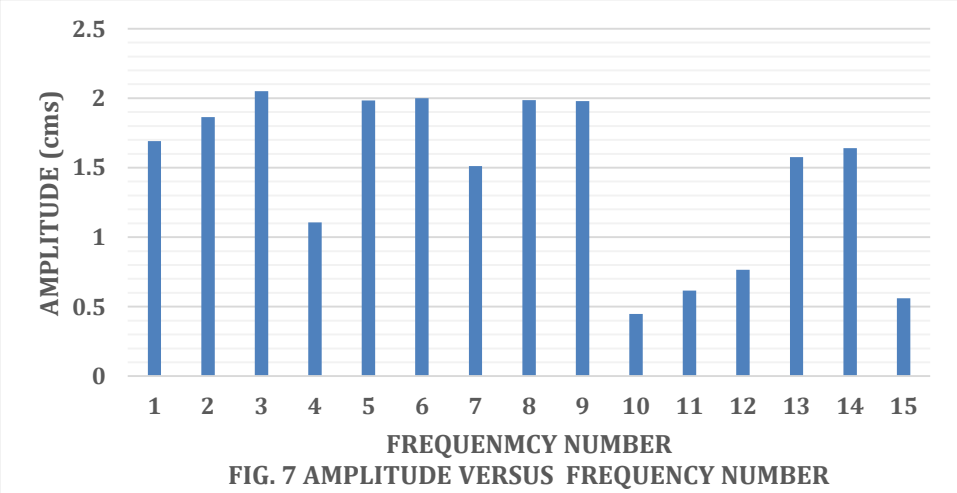


FIG. 7 AMPLITUDE VERSUS FREQUENCY NUMBER