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On The Continuous Water Shortage In Vidarbha And The Need For Greater Emphasis On Monsoon Rainfall Scientific Studies In India

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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

I. INSUFFICIENT RAIN AND ITS EFFECT ON LIVES OF PEOPLE – DEPLETION OF WATER RESERVES

India is a diverse country and so is the rainfall in different areas of India. The Indian Meteorological Department (IMD) every year around April – May comes up with predictions of rainfall in India. They emphasize the overall rainfall - year after year. The pitfall of this kind of projection is that there are regions which are rain deficient - year after year. The plight of the people of these areas remains covered up in the overall predictions. For example when they say that average rainfall will be slightly less than the average, it does not give true picture to those people who sufferr from continuous shortfall of rains. Some other areas may have above average rainfall but this does not help those who are suffering from water shortages every year. The result is that in these areas the government does not offer help that is needed. The people in such areas do not have sufficient amount of even drinking water let alone water for irrigation.

About 75 to 90% of the annual rainfall takes place in Monsoon season (June to September). Here, the rain water is needed for agriculture because only 40 percent of the cultivated area is irrigated. India's 70 percent of the irrigated area is used for food crops. Year after year more water is needed in overall agriculture. The total rainfalls have not increased whereas- to meet the needs of the growing population- more land and more resources are needed. The need for water is so large that the rainfall rarely meets the need and it results in depletion of water reserves. In 1998, the groundwater, one of the forms of water reserves - had its utilization 38 percent, which increased to 58 percent in 2009. Similarly large number of dams have been built on rivers causing shortage of water downstream.

The Himalayan glaciers are melting thereby the reserves in form of glaciers are also getting depleted.

When it rains, the water is in pure form and can be used for drinking, irrigation, daily use and generation of hydro-power. We have not given importance to its quality. We badly need water conservation projects which are few and far between. Water in rivers keeps flowing into the ocean or after the rainy season – not much is left for subsequent seasons.

Hence, water is needed for agriculture, city supplies including drinking, power generation, as well as in many industrial processes. The only new source or input is the rain water.

Therefore, it is critical that the study on rainfall be made. The present study has been undertaken to analyze water shortage due to insufficient rainfall in India's one of the most drought prone areas [refer to Fig. 1].

As far as agriculture is concerned, lack of rain results in large number of farmers committing suicides [1-5]. Water shortage studies can also be seen in [6-15]. Water shortage also affects the hydropower generation [16].

Given all of the above, it is desirable that we come up with a model to predict monsoon rainfall far in advance to that of the IMD 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). This way, the farmers can decide what to plant and how much to plant? The farmers are under heavy loans and a drought breaks their backs. In case of advance knowledge about a drought -it will help farmers in avoiding loans. Similarly, in several cases one can have idea about floods also because it is caused by excess rain of a river basin.

One can refer to work of some scientists working in this area [17-20]. The rainfall predictions by IMD can be seen in [21]

In the present study, the prediction can be made about 8 months in advance, if needed, just after the end of the previous Monsoon season. It is based on current 32- year rainfall history of an area. 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.

II. ANALYSIS AND PREDICTION OF RAINFALL IN THE COMING MONSOON SEASON

Figs. 2 to 5 show plots of yearly rains starting from 1986 to 2017 for the, months of June to September. On the other hand Fig. 6 shows rains for all these months in combined form.

In Fig. 2, 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 represents the actual rain values. The details about these two methods can be seen in [22, 23].

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

Predicted Value = Average Value + (0.2 x Average Value) (r-0.5)

Table 1 shows the summary of all the results. 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.

One can also see that all figures (Figs 2 to 6) show increasing trend in the rainfall amount.

In this table, the difference between the Time Series method and the FFT method is small until Fig. 4 but the difference is substantial in Figs 5 and 6.

Except in the month of June, for other months - the predicted amount is less than the 32 year average amount for the year 2018 (see Table 1)

Fig. 7 shows the frequency content of the total rainfall. It shows the presence of several lower and higher frequencies. The rapid change in the amount of rainfall from one year to another is due to the presence of significant number of higher frequencies.

III. CONCLUSIONS

1. The rainfall in the month of June will be slight above the 32 yer average.
2. The rainfalls in other months will be less than the corresponding average which includes the total vale also.
3. India needs to lay greater importance in setting aside resources towards the impending water shortages and much more so in those areas which continuously suffer from deficient rain.

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

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
TIME SERIES	2018	20.7	34.5	31.5	17.5	104	
FAST FOURIER TRANSFORM (FFT)	2018	23.0	23.0	31.7	11.0	80.5	
AVERAGE OF TIME SERIES AND FFT METHODS	2018	21.85	28.75	31.6	14.25	92.25	
PREDICTED AMOUNT	2018	23.2	26.4	29.4	13.2	95.1	Less Than the 32 Year Average Value – 11.038 % less
32 YEAR AVERAGE		21.3	33.2	30.6	21.8	106.9	

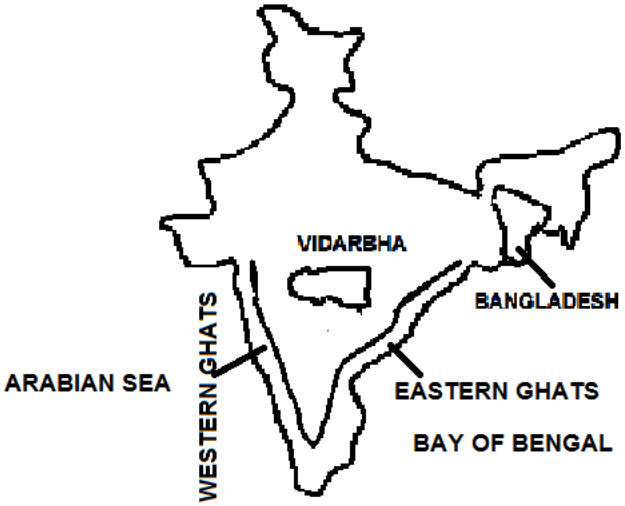

FIG. 1 LOCATION OF VIDARBHA BETWEEN EASTERN AND WESTERN GHATS

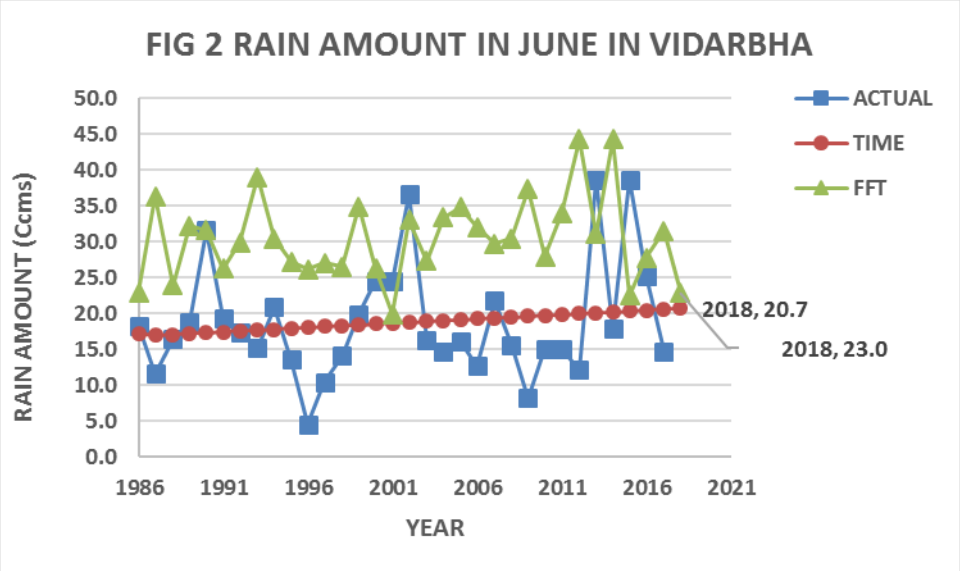
FIG 2 RAIN AMOUNT IN JUNE IN VIDARBHA
RAIN AMOUNT (Ccms)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1986
1991
1996
2001
2006
2011
2016
2021
YEAR
ACTUAL
TIME
FFT
2018, 20.7
2018, 23.0

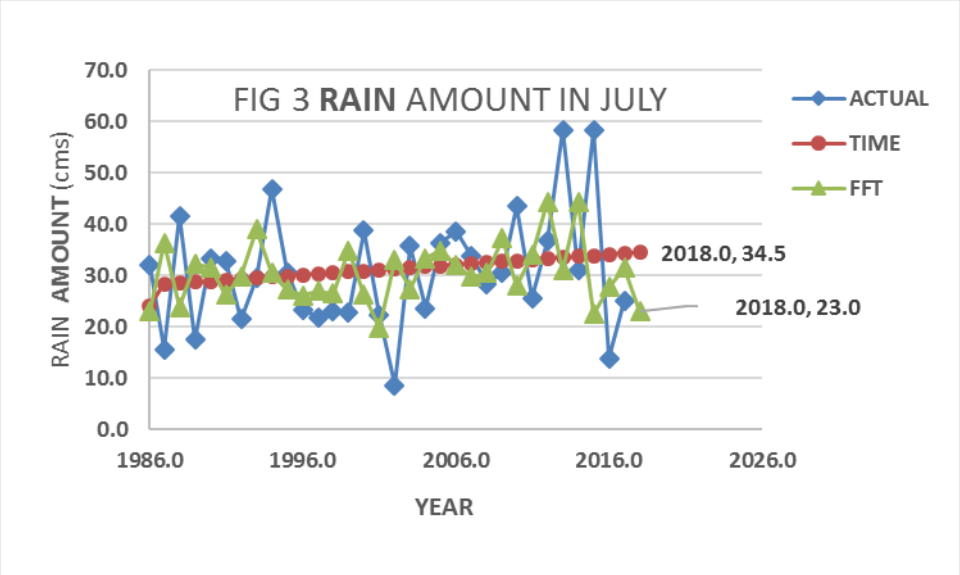
FIG 3 RAIN AMOUNT IN JULY
RAIN AMOUNT (cms)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1986.0
1996.0
2006.0
2016.0
2026.0
YEAR
ACTUAL
TIME
FFT
2018.0, 34.5
2018.0, 23.0

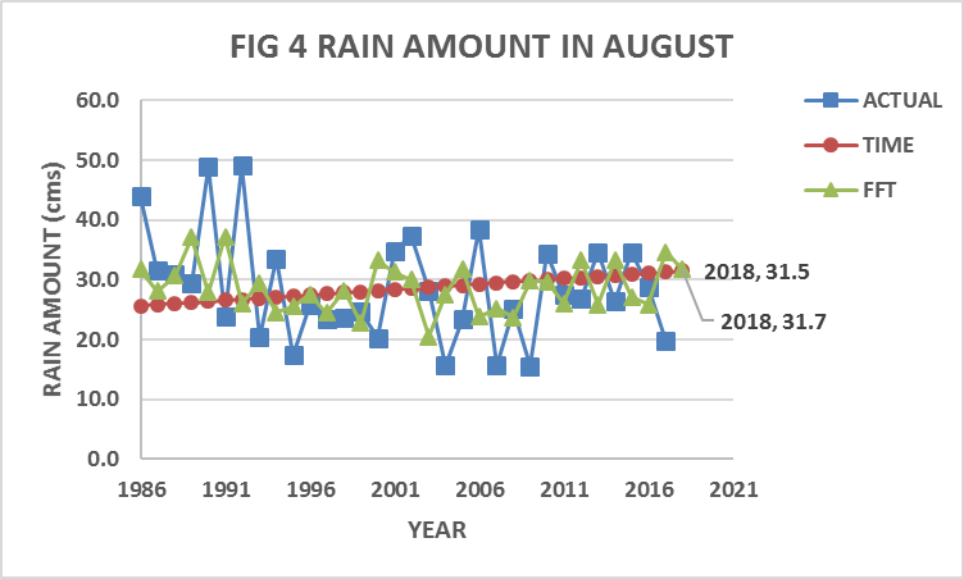
FIG 4 RAIN AMOUNT IN AUGUST
RAIN AMOUNT (cms)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1986
1991
1996
2001
2006
2011
2016
2021
YEAR
ACTUAL
TIME
FFT
2018, 31.5
2018, 31.7

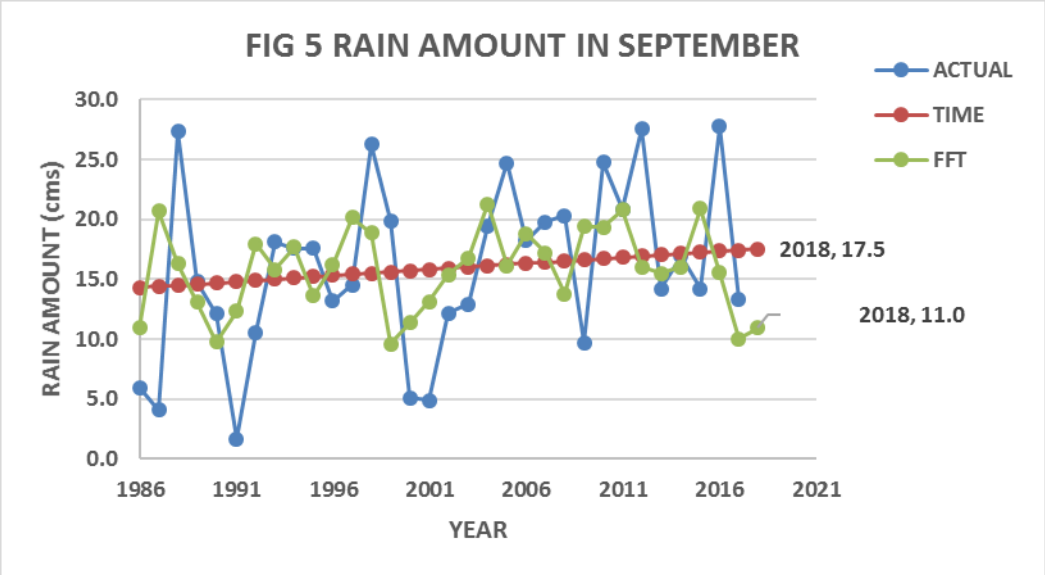
FIG 5 RAIN AMOUNT IN SEPTEMBER
RAIN AMOUNT (cms)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1986
1991
1996
2001
2006
2011
2016
2021
YEAR
ACTUAL
TIME
FFT
2018, 17.5
2018, 11.0

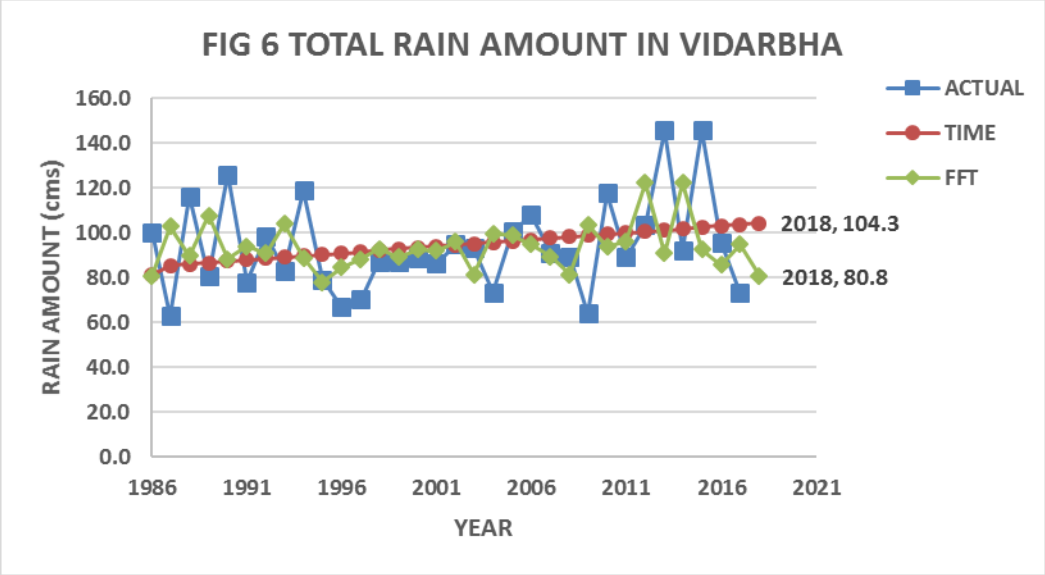
FIG 6 TOTAL RAIN AMOUNT IN VIDARBHA
RAIN AMOUNT (cms)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1986
1991
1996
2001
2006
2011
2016
2021
YEAR
ACTUAL
TIME
FFT
2018, 104.3
2018, 80.8

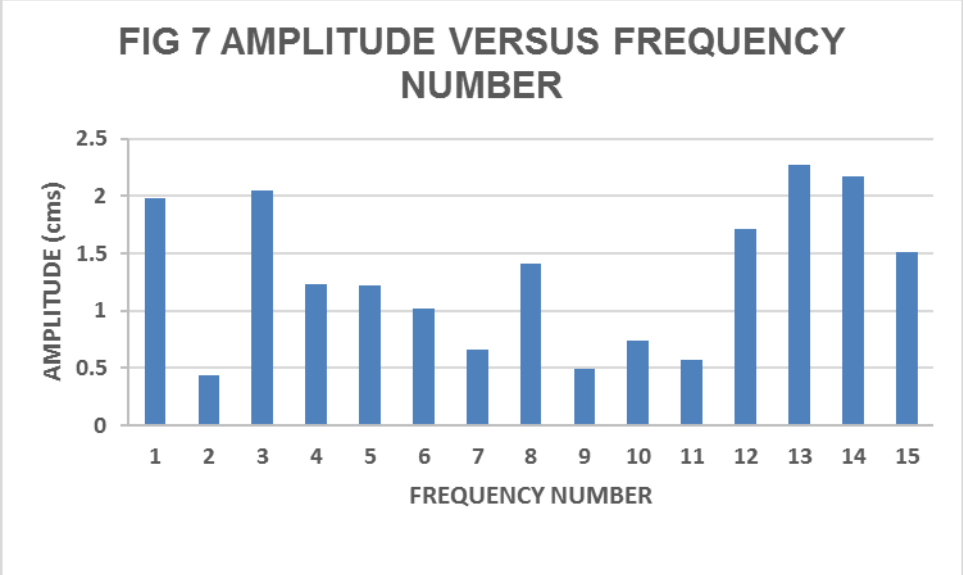
FIG 7 AMPLITUDE VERSUS FREQUENCY NUMBER
AMPLITUDE (cms)
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
FREQUENCY NUMBER