ON THE RAINFALL IN MARATHAWADA AND THE NEED FOR FARMERS TO HAVE AN ALTERNATIVE SOURCE OF INCOME

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ABSTRACT

In this work the rainfall in Marathawada is studied, and possible source of erraticism is analyzed. Based on the historical data, prediction of rain in the year 2015 is made.

Since the rain amount varies widely from year to year, it would be advisable for the farmers to have an alternative for irrigation or have alternate sources of income.

Since the prediction is being made well in advance, it gives sufficient time to farmers to select future course of action.

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

1. RAIN AND AGRICULTURE

The farmers of Marathawada have historically suffered from the problem of undependability of rain in crop planting and healthy agricultural output. Irrigation using pumps is not as simple because of higher energy costs such as that of Diesel fuel used in pumps

Another factor which is playing havoc in the rainfall is the global warming which has introduced increased uncertainty in preparing for planting crops. This planting period is very sensitive and critical. Such crop failures lead to large scale migrations from the villages to cities where people can earn some money to survive. This migration causes increased load on city's services and it increases slum areas in the cities.

Crop failure brings extreme hardships to the farmers and some even commit suicide due to despair [1-8]

Vidarbha, Telangana, and Marathawada lie in the Central and Southern India as shown in Fig. 1 where its location is away from both the Western Ghats and the Eastern Ghats from where the monsoon approaches the Indian subcontinent. It rains heavily between the Ghats and the sea but these Ghats act as a barrier for smooth rainfall transition between the coast and inland. There is a steep gradient in rainfall between the coasts and these three areas. To the south of Vidarbha is the Telangana region and on the southwest is the Marathwada region, and all of these regions suffer from droughts from time to time.

In history, Daulatabad near Aurangabad in Marathawada, starting in 1327, it famously remained the capital of Tughlaq dynasty, under Muhammad bin Tughluq (r. 1325-1351). He forcibly moved the entire population of Delhi here, for two years, before it was abandoned due to lack of water [9]. Bihar is another region where droughts take place [10].

2. RAIN PREDICTION IN INDIA

India's primary information about rain comes from India Meteorological Department (IMD) [11]. India has emphasized fair amount on research on rain predictions and many scientists are quite actively pursuing research in this respect. It is known that monsoon is predicted either by statistical models based on analysis of historical data to determine the relationship of Indian Summer Monsoon Rainfall (ISMR), to a variety of atmospheric and oceanic variables over different parts of the world prior to the summer monsoon season, or by dynamical models based on the laws of physics [12,13] .

The unfortunate fact is that the farmers cannot reply on such predictions either by IMD or these scientists and many farmers are committing suicides.

Irrespective of methods used above, their validity over large tract of land area cannot be held as reliable because of their dependence merely on atmospheric and ocean parameters. The convective conditions over the land areas are entirely different. India is a vast country with widely different topography. The IMD is in Maharashtra and other scientists carry out research not far from these regions where the farmers are committing suicide.

In view of the above argument, there is a need to have an alternate and reliable method of prediction for places like Vidarbha, Telangana, Marathawada etc because the agriculturists are mainly of lower income group and non-reliability of rainfall causes intense hardships to them. Not only this, the country as a whole is quite cautious about grain production and has been quite hesitant to sign agreement in the World Trade Organization (WTO) over the storage or having buffer grain stock.

The farmers need fair bit of advance information to plan for seeds, and other necessities like finance to negotiate from the banks or other lenders. The uncertainties in rain cause hardships even suicides amongst the farmers [1-8]. They borrow money at high interest rate and crop failure puts them in awkward position where they could lose their houses or other assets by defaulting on payments.

The crops can fail if (a) there is scanty rain in June or (b) the total rain is not sufficient in the rainy season between June to September. In other words, based on (a) timeliness of rain is also extremely important and is discussed in [10].

3. RAIN DATA AND ANALYSIS

Figs. 2 to 5 show plots of yearly rains starting from 1981 to 2012 for the months of June to September whereas Fig. 6 shows rains for all these months in combined form. This shows a slightly but not much decreasing trend after regression analysis from year to year. This record (Fig. 6) has on an average or the mean value of 27.368 inches of rain. Indian Meteorological Department defines normal rain if the values lie between plus or minus 19% of the mean value. Although in absolute sense, this mean varies from region to region. One can clearly see that the plot has many ups and downs. However, low amount of rain causes drought conditions such as in 2009, or 2012 in Fig. 6.

What is strange about Marathawada is that the rain history (rain amount) is very erratic – it has very wide variation from year to year which is very detrimental in crop planning.

The first important factor which ought to be emphasized is the timeliness of rain for planting crop as stated earlier [10]. If the rain is delayed too much then the hardship is going to be there. Fig. 2 shows the variation in rain in the month of June starting from the year 1981. It shows that there exists history of deficient rain i.e. rain below lower limit. The lower or upper limits are 19% of the mean value. In these years, the farmers have difficulties in planting the crop.

Fig. 3 also shows that in the past many years the rainfalls were deficient in July. Fig. 2 also shows deficient rains in many years- more than July months. The rains in Fig. 4 in August were below the lower limit much more than those in July. As far as the months of September (refer to Fig. 5) are concerned, the rains have been either above or near the upper limit or below or near the lower limit.

Fig. 5 shows rain in September and it also shows that the rains have been, of late, been quite frequently below the lower limit which was bad for agriculture. In this figure only, the results obtained by Maple software which computed the rain amount based on the frequency and amplitude data in accordance with the Fourier series. The frequency and amplitude information was obtained using Fast Fourier Transforms (FFT) using Excel software. The results here show slightly different values from the actual rain data,

To get better insight into the total amount of rain over the years one can see Fig. 6. The same data was analyzed in the frequency domain using Fast Fourier Transforms (FFT), and the results are shown in Fig. 7 [14,15]. It shows frequency numbers which are quite significant are 3, 4, 6, 7, and 13. The number 3, points out the frequency corresponding to the El Nino or its counterpart La Nina effect which occur every 10.67 years. Frequency 4 which has large amplitude has a period of 8 years. Remarkable fact is that number 13, which has much higher frequency with greater amplitudes. This shows that the change in rain amount will be very rapid from year to year. This rapid fluctuation in the amount of rain throws off the planning for the crops

This rainfall data's statistical distribution was plotted and the result is shown in Fig. 8 which shows slight difference from a normal distribution curve especially at higher value of rain. This was further checked using chi squared test using software called MATLAB. Fig. 9 shows the cumulative probability values is quite close to a normal distribution.

All figures – 2 to 6 show plots of the actual data and the results of FFT method i.e. after obtaining Fourier coefficients using FFT; the time dependent results were calculated using the Fourier series. It shows a very close match between the two (actual and its FFT model).

4. RAINFALL PREDICTION

It was not possible for the author to obtain data beyond 2012. For year 2013 onwards, the rain data were not posted on its (IMD's) web i.e. region by region data on IMD website.

India is a country which depends upon agriculture as one of its main component of the Gross Domestic Product (GDP). Therefore, the government ought to be current in providing information in the public domain for better productivity in the agriculture sector. The information should not be kept a secret but it should be widely available in the IMD's regional offices as well as state governments offices in full public view.

Similarly, IMD's monsoon predictions should be reliable - region by region. For example the farmers of these areas should know the amount of rainfall that is predicted for next year as early as possible with sufficient lead time . This is for possible planning of the crops and the prediction should also be as accurate as possible. This is not the case presently unfortunately.

Table 1 shows the results for June for years 2013 onwards. Here the results of the Time Series method were arrived at using regression analysis where the monthly variations were averaged out over the span between 2001 to 2012. It showed descending trend but yielded conservative results.

The prediction was based on weighted average ratio of 3:1 between the results obtained by FFT and Time Series methods. For example in Table 1 in the year 2013 , the value of 4.301486385as prediction was arrived at as (3 x4.52259+ 3.638175541) /4 .

The results show that in the month of June, it is projected as normal in the year 2013 but deficient in the other two projected years.

Table 2 shows that the rains are expected to be normal in these years in the month of July.

In the month of August (Table 3) , it would be deficient in the years 2013, and 2014 whereas in Table 4, it would be greater than the upper limit of the normal range in two of the three years.

The total rain values are shown in Table 5 which shows that if the total values are considered then it would be normal in 2013, and 2014 but excess in 2015.

This clearly shows the fallacy in coming to the conclusion based on the total values because if the rain is deficient when the crops are planted in June, then farmers would lose their crop even if the deficient rain is made up in latter months.

6 CONCLUSIONS

In this work, at first a brief review of the drought or famine in Telangana area was carried out. It was found that Marathawada has had severe drought conditions in the past.

The historical rain data showed that Marathawada has had slight decreasing trend in rainfall (Time Series method).

At first a suitable model was searched for and it was found necessary to analyze the possible causes of the rainfall variations by looking at the frequency spectrum. The identified frequencies included the El Nino and La Nina effects amongst the others. The dominant frequencies were 3, 4, 6, 7 and 13 – of these 4, and 13 are the higher amplitude frequencies. The higher frequencies like 13 give rise to rapid changes in rainfall about the mean value.

The rainfall predictions were made using Fourier series method and Time Series which uses Moving Average Method of rainfall and linear regression analysis. The weightage ratio of 3:1 between the two methods was selected because the FFT method fitted the actual rain data very well.

Based on this analysis, the prediction for the Year 2015 is that there will be excess rain in September but deficient in June. Months of July and August will be normal in this respect.

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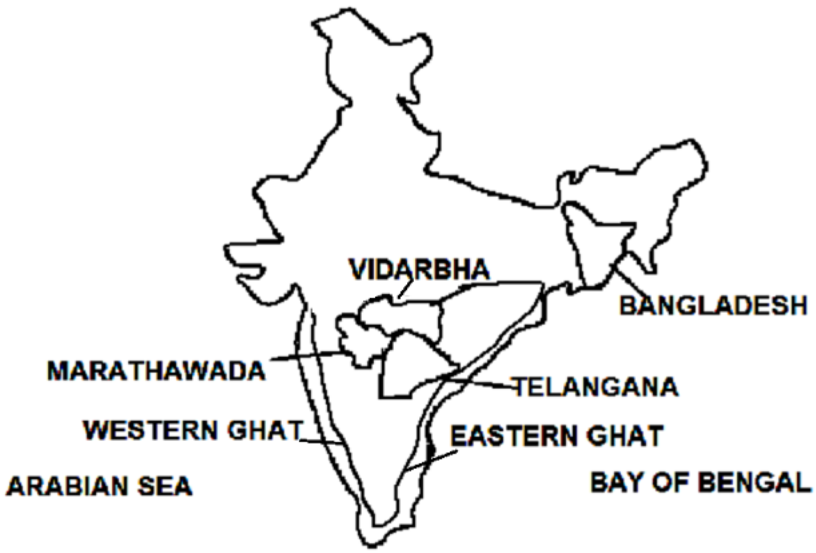


FIG. 1 LOCATIONS OF MARATHAWADA. VIDARBHA.
AND TELANGANA BETWEEN WESTERN AND EASTERN GHATS

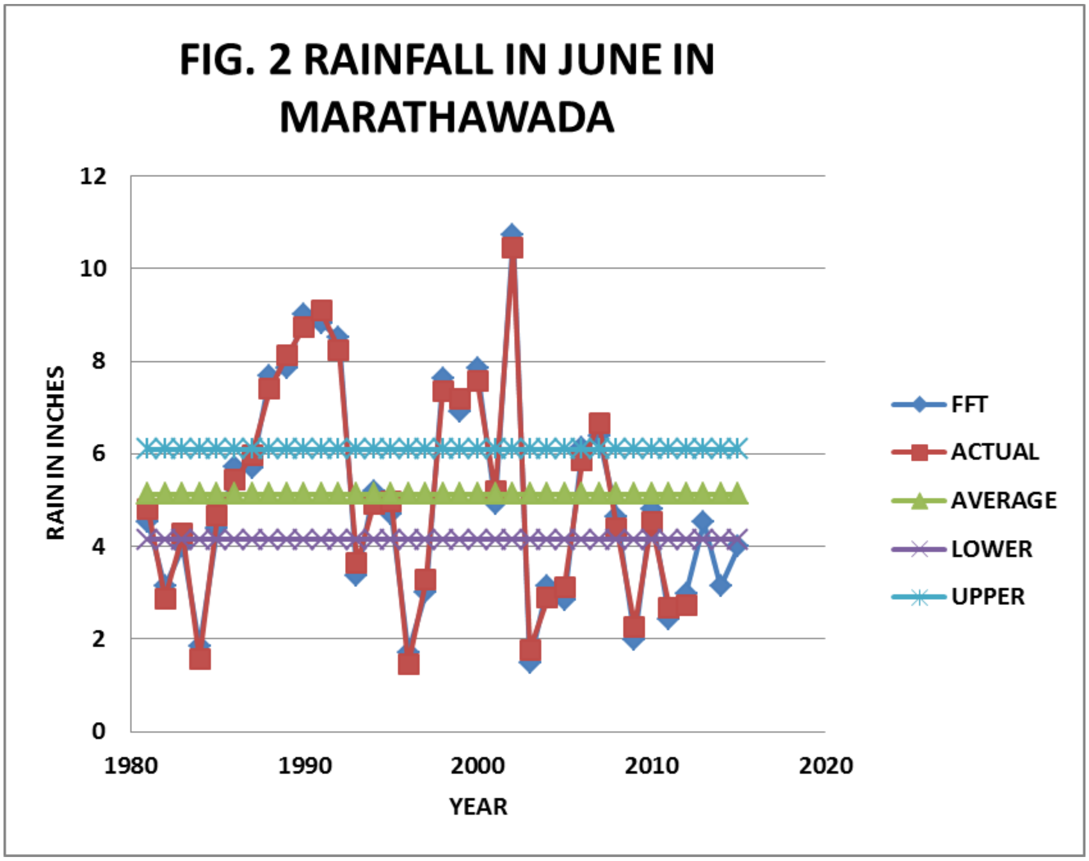


FIG. 2 RAINFALL IN JUNE IN MARATHAWADA
RAIN IN INCHES
12
10
8
6
4
2
0
1980
1990
2000
2010
2020
YEAR
FFT
ACTUAL
AVERAGE
LOWER
UPPER

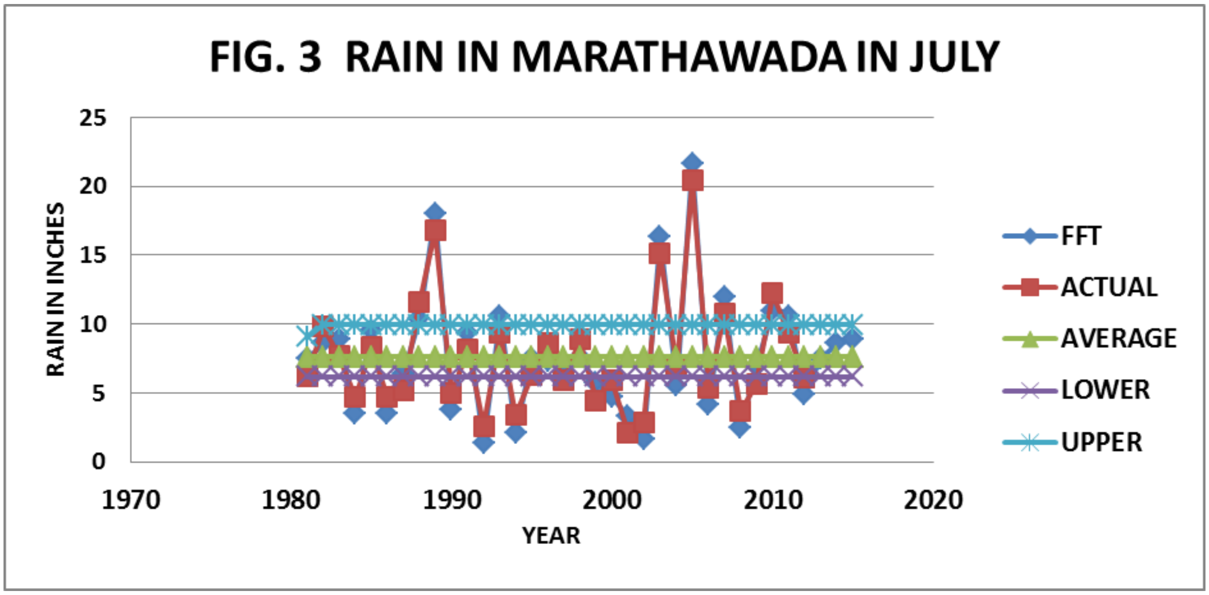


FIG. 3 RAIN IN MARATHAWADA IN JULY
RAIN IN INCHES
25
20
15
10
5
0
1970
1980
1990
2000
2010
2020
YEAR
FFT
ACTUAL
AVERAGE
LOWER
UPPER

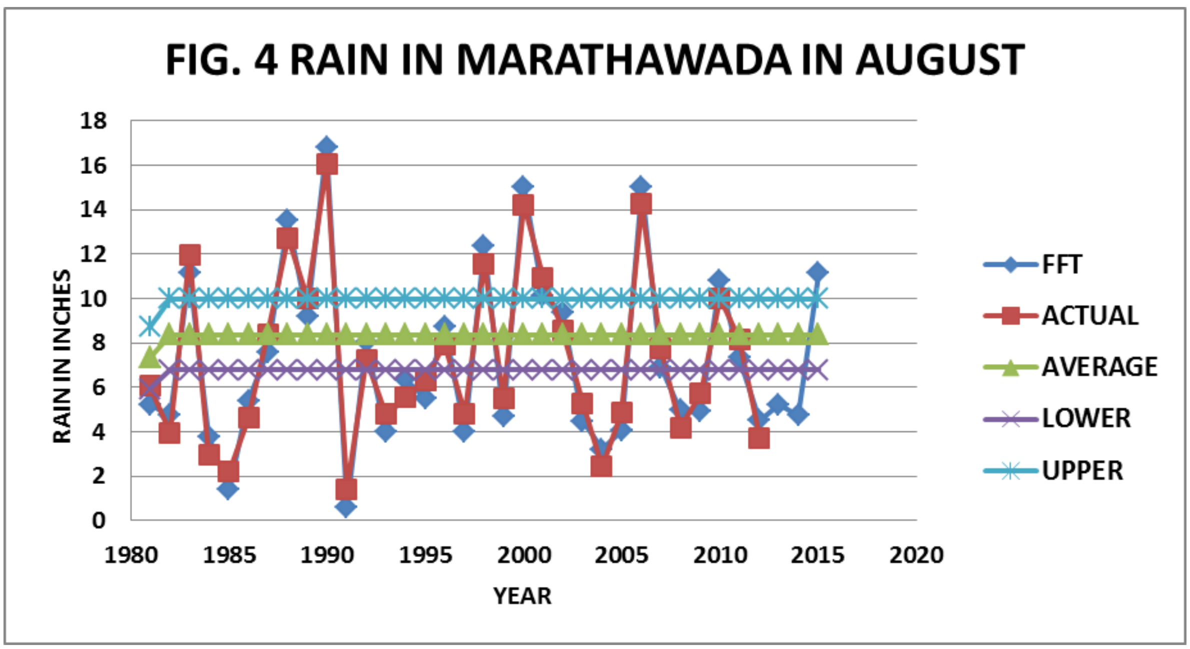


FIG. 4 RAIN IN MARATHAWADA IN AUGUST
RAIN IN INCHES
18
16
14
12
10
8
6
4
2
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
YEAR
FFT
ACTUAL
AVERAGE
LOWER
UPPER

FIG. 5 RAIN IN MARATHAWADA IN SEPTEMBER

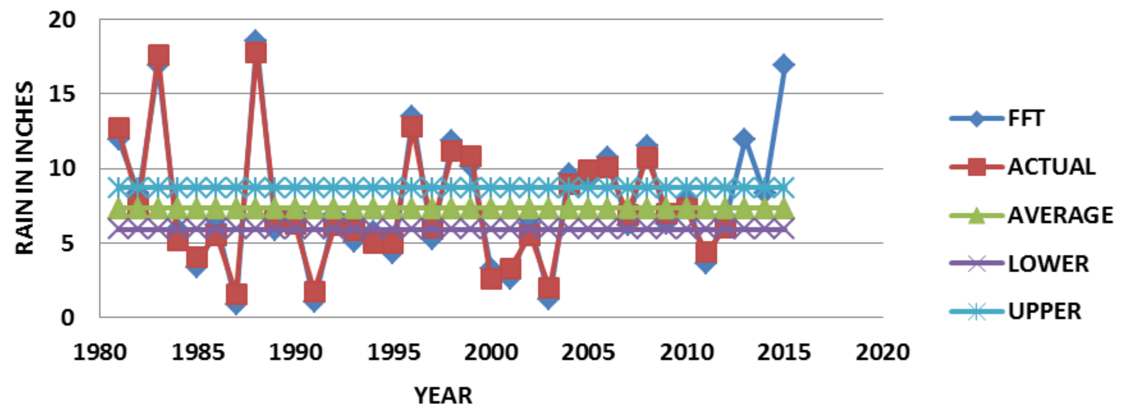


FIG. 6 RAIN IN MARATHAWADA BETWEEN JUNE TO SEPTEMBER

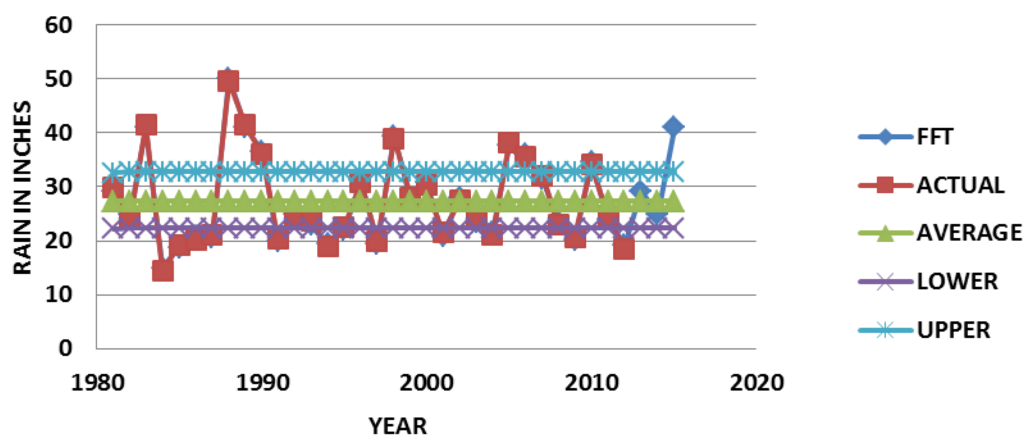
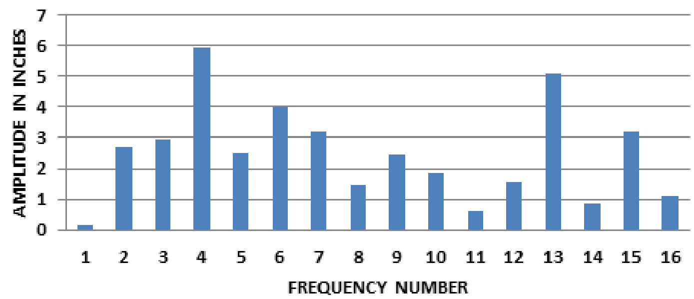


FIG. 7 AMPLITUDE VERSUS FREQUENCY NUMBER



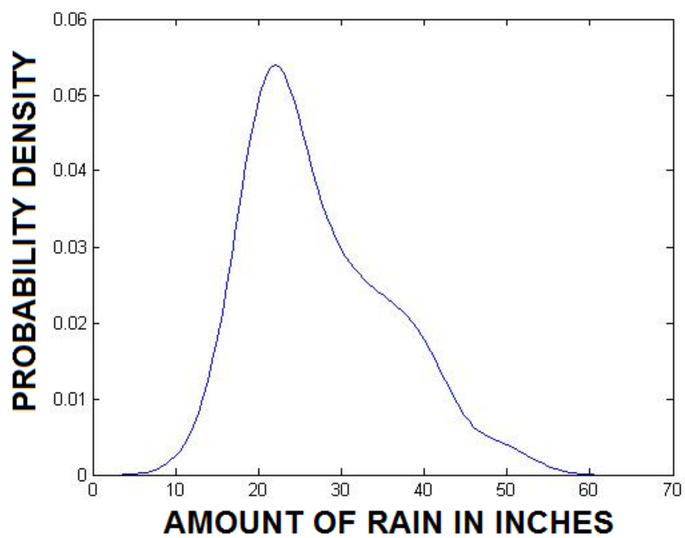


FIG. 8 PROBABILITY DENSITY FUNCTION

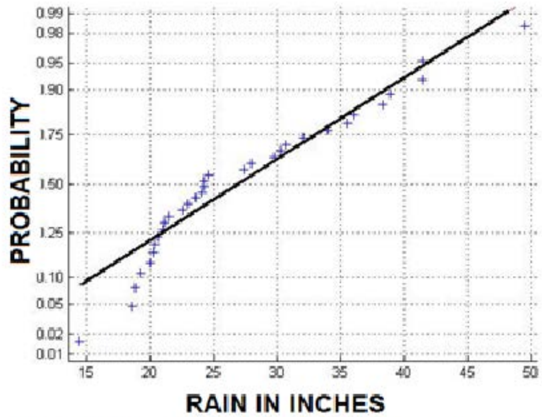


FIG. 9 THE NORMAL PROBABILITY PLOT

TABLE 1 PREDICTED RESULT FOR THE MONTH OF JUNE FOR YEARS 2013 TO 2015

JUNE	2013	2014	2015
TIME SERIES	3.638175541	3.507388022	3.376600503
FFT	4.52259	3.14268	3.99904
PREDICTION	4.301486385	3.233857006	3.843430126
AVERAGE	5.124876969	5.124876969	5.124876969
LOWER	4.151150344	4.151150344	4.151150344
UPPER	6.098603593	6.098603593	6.098603593
CLASSIFICATION	**NORMAL**	**DEFICIENT**	**DEFICIENT**

TABLE 2 PREDICTED RESULTS FOR THE MONTHS OF JULY FOR YEARS 2013 TO 2015

JULY	2013	2014	2015
TIME SERIES	7.225117475	6.96350328	6.701889085
FFT	7.47418	8.58136	8.89469
PREDICTION	7.411914369	8.17689582	8.346489771
AVERAGE	7.617864173	7.617864173	7.617864173
LOWER	6.17046998	6.17046998	6.17046998
UPPER	9.934479577	9.934479577	9.934479577
CLASSIFICATION	**NORMAL**	**NORMAL**	**NORMAL**

TABLE 3 PREDICTED RESULTS FOR THE MONTHS OF AUGUST FOR YEARS 2013 TO 2015

AUGUST	2013	2014	2015
TIME SERIES	5.744561277	5.535039208	5.325517139
FFT	5.23627	4.74566	11.1304
PREDICTION	5.363342819	4.943004802	9.679179285
AVERAGE	8.38238189	8.38238189	8.38238189
LOWER	6.789729331	6.789729331	6.789729331
UPPER	9.975034449	9.975034449	9.975034449
CLASSIFICATION	**DEFICIENT**	**DEFICIENT**	**NORMAL**

TABLE 4 PREDICTED RESULTS FOR THE MONTH OF SEPTEMBER FOR YEARS 2013 TO 2015

SEPTEMBER	2013	2014	2015
TIME SERIES	5.744363069	5.533308667	5.322254264
FFT	11.9731	8.31425	16.8871
PREDICTION	10.41591577	7.619014667	13.99588857
AVERAGE	7.305364173	7.305364173	7.305364173
LOWER LIMIT	5.91734498	5.91734498	5.91734498
UPPER LIMIT	8.693383366	8.693383366	8.693383366
CLASSIFICATION	**EXCESS**	**NORMAL**	**EXCESS**

TABLE 5 PREDICTED RESULTS FOR THE MONTHS OF JUNE TO SEPTEMBER COMBINED FOR YEARS 2013 TO 2015

JUNE-SEPT	2013	2014	2015
TIME SERIES	22.35221736	21.53923918	20.72626099
FFT	29.2212	24.799	40.9263
PREDICTION	27.50395434	23.9840598	35.87629025
AVERAGE	27.36847933	27.36847933	27.36847933
LOWER	22.32303396	22.32303396	22.32303396
UPPER	32.79556841	32.79556841	32.79556841
CLASSIFICATION	**NORMAL**	**NORMAL**	**EXCESS**