Monsoon Season Rain Prediction for the Year 2015 for Telangana, India Based on Telangana's Historical Rain Data

Anand M. Sharan*

Mechanical Engineering Department, Faculty of Engineering, Memorial University of Newfoundland, St. John's, Newfoundland, Canada

Abstract: In this work the prediction of rain is based on average of two methods. In these methods, historical rain data of Telangana from 1981 to 2012 are selected for projection. These methods take into account the trends in rain pattern also. Among the results are the effects of El Nino and La Nina which for Telangana are not as significant as compared to higher frequencies on annual rainfall basis. The period of these combined effects (El Nino and La Nina) is 10.67 years. The average rainfall of Telangana is 70 centimeters (cms). The normal range of rain varies between the mean±standard deviation as per the Indian Meteorological Department (IMD). The forecast is being made in November 2014 for the Year 2015 that the rain will be normal in the month of June whereas some excess rain will take place in later months as shown in Tables **1** to **5** here. The advantage of this approach is that it gives farmers far more time than they get presently when preliminary predictions are announced by Indian Meteorological Department in April for each monsoon.

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

India is primarily dependent on its agricultural output which constitutes its major fraction of Gross Domestic Product (GDP). Majority of Indians still live in villages where agriculture is their mainstay. The agriculture sector is highly dependent on rain which India gets from South–West monsoon rains (from the Arabian Sea) and from the Bay of Bengal. These rains occur during the months between June to September.

Higher energy costs such as Diesel fuel used in pumps - have added to the country's foreign exchange needs and India is highly deficient in energy sources. This requires that the information about the amount of rain to be expected in coming season be known as accurately as possible.

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 otherwise the farmers would have to wait for another year where these people do not have alternate means to earn their living. 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.

*Address correspondence to this author at the Mechanical Engineering Department, Faculty of Engineering, Memorial University of Newfoundland, St. John's, Newfoundland, Canada a1b 3 x 5; Tel: (709) 864-8930; Fax: (709) 864-4042; E-mail: asharan@mun.ca

Vidarbha, Telangana, and Marathawada lie in the Central and Southern India as shown in Figure **1** where their locations are away from both the Western Ghat and the Eastern Ghat 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. Therefore, a steep gradient in rainfall exists 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.

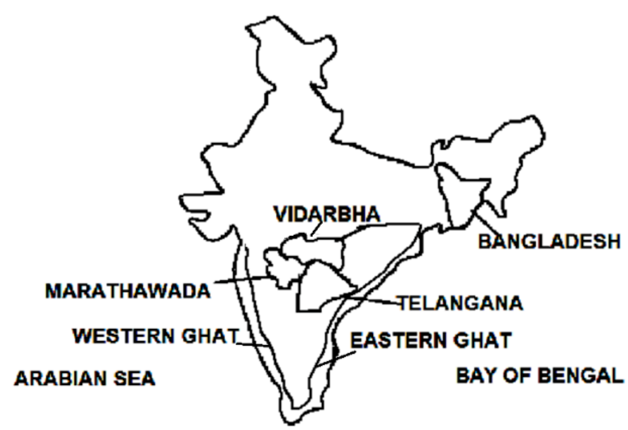


Figure 1: Locations of marathawada. vidarbha and telangana between western and eastern ghats.

The news about farmers' suicides is widespread; the author was drawn to such news and wanted to understand the problem closely [1-5]. Besides this, in history, Daulatabad near Aurangabad in Marathawada, remained the capital of Tughlaq

E-ISSN: 2410-3624/15

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 [6]. Bihar is another region where droughts take place but not much news about suicides is published in the newspapers [7].

2. RAIN PREDICTION IN INDIA

Global warming has introduced uncertainty of rain in different countries [8-10] India's primary information about rain comes from India Meteorological Department (IMD) [11]. India has laid emphasis by fair amount on research on rain predictions. Many scientists are 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. They have also come up with dynamical models based on the laws of physics [12, 13].

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.

In view of the above argument, there is a need to have an alternate and reliable method of prediction for places like Vidarbha, Telangana etc because the agriculturists are mainly of lower income group and un-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 [1-5]. 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 [7].

3. RAIN DATA AND ANALYSIS

Figures **2** to **5** show plots of yearly rains starting from 1981 to 2012 for the months of June to September whereas Figure **6** shows rains for all these months in combined form. This shows a slightly but not much increasing trend after regression analysis from year to year. This record (Figure **6**) has on an average or the mean value of 70 cms 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 in Figure **6**.

What is strange about Telangana's rain history is that the rain amount is very erratic – it has very wide swing 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 [7]. If the rain is delayed too much then the hardship is going to be there. Figure **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.

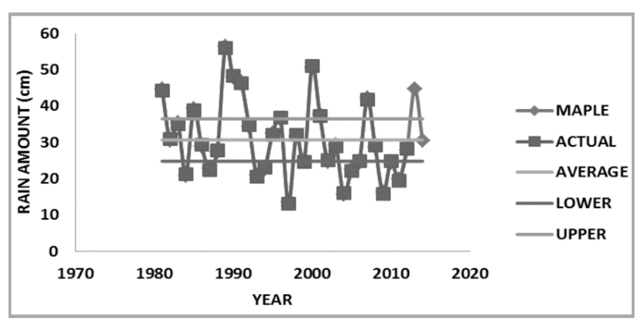


Figure 2: Rainfall in june.

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

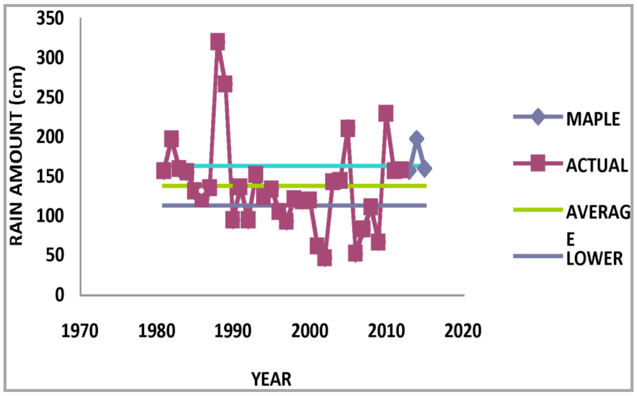
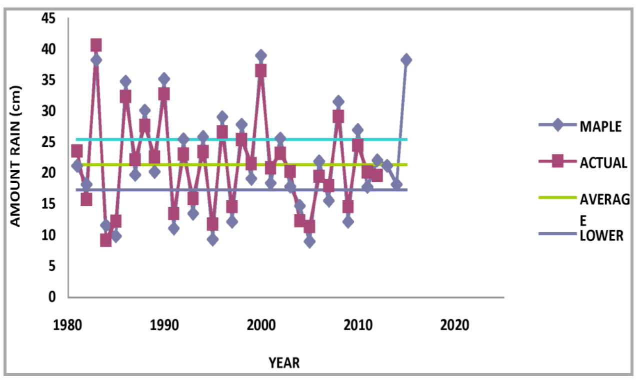


Figure 3: Rain in july.



Figuer 4: Rain month of august.

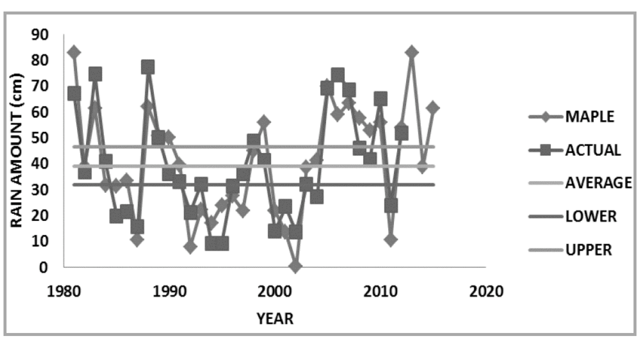


Figure 5: Rain in september.

Figure **5** shows rain in September and it also shows that the rains, of late, have 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 Figure **6**. The same data was analyzed in the frequency domain using Fast Fourier Transforms (FFT), and the results are shown in Figure **7** [14, 15]. It shows frequency numbers which are quite significant are 1, 3, 4, 6, 12, 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. Remarkable fact is that numbers 12, and 13, which have much higher frequencies 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.

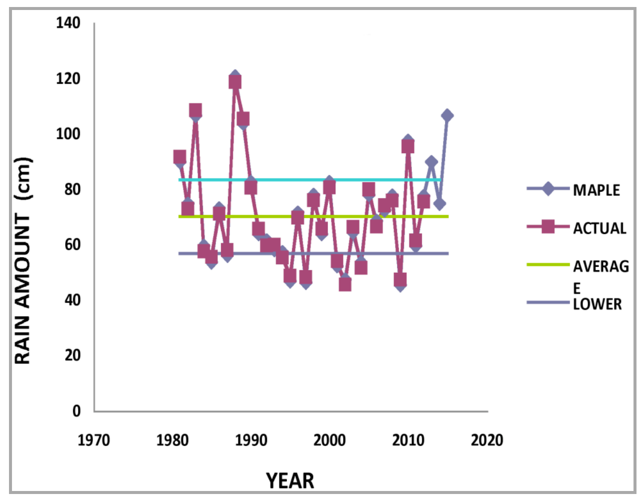


Figure 6: Rain in months of june to september.

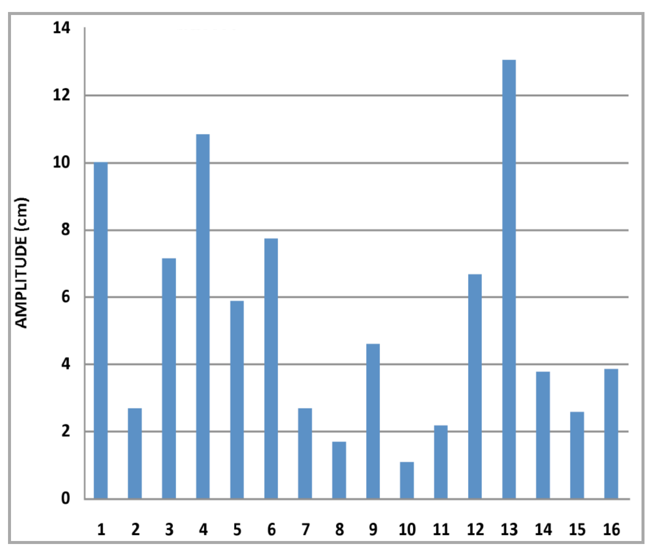


Figure 7: Amplitude versus frequency number.

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

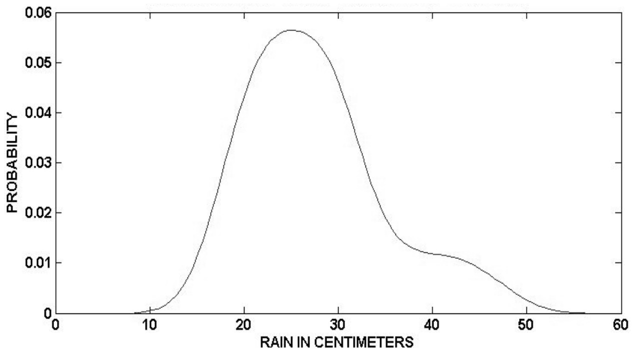


Figure 8: Probability density function of total rain.

All Figures **3** to **7** 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 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 planning of the crops. Needless to say, 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 ascending 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 15.8 as prediction was arrived at as (3 x 17.6 + 10.2)/4.

Table 1: Predicted Result for the Month of June for Years 2013 to 2015

June	2013	2014	2015
Time Series	10.2	7.8	7.9
FFT	17.6	12.0	13.9
Prediction	15.8	10.9	12.4
Average	12.1	12.1	12.1
Lower	9.8	9.8	9.8
Upper	14.4	14.4	14.4
Classification	**Excess**	**Normal**	**Normal**

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

Table **2** shows that the rains are expected to be normal in two years in the month of July, but excess in 2014.

Table 2: Predicted Results in Centimeters for the Months of July for Years 2013 to 2015

July	2013	2014	2015
Time Series	19.5	10.2	10.3
FFT	24.2	30.5	24.6
Prediction	23.0	25.4	21.0
Average	21.2	21.2	21.2
Lower	17.4	17.4	17.4
Upper	25.2	25.2	25.2
Classification	**Normal**	**Excess**	**Normal**

In the month of August (Table **3**), it would be excess only in the year 2015 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 in excess in two of the three years.

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.

Table 3: Predicted Results in Centimeters for the Months of August for Years 2013 to 2015

August	2013	2014	2015
Time Series	20.5	20.6	20.6
FFT	21.0	18.1	38.1
Prediction	20.9	18.7	33.8
Average	21.3	21.3	21.3
Lower	17.2	17.2	17.2
Upper	25.3	25.3	25.3
Classification	**Normal**	**Normal**	**Excess**

Table 4: Predicted Results in Centimeters for the Month Of September for Years 2013 to 2015

September	2013	2014	2015
Time Series	17.5	17.6	17.7
FFT	32.7	15.4	24.2
Prediction	28.9	15.9	22.6
Average	15.4	15.4	15.4
Lower	12.5	12.5	12.5
Upper	18.4	18.4	18.4
Classification	**Excess**	**Normal**	**Excess**

Table 5: Predicted Results in Centimeters for the Months of June to September Combined for Years 2013 to 2015

June-Sept	2013	2014	2015
Time Series	67.7	68.0	68.2
FFT	89.6	74.7	106.4
Prediction	84.1	73.0	96.8
Average	70.0	70.0	70.0
Lower	56.7	56.7	56.7
Upper	83.3	83.3	83.3
Classification	**Excess**	**Normal**	**Excess**

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 Telangana has had severe drought conditions in the past.

The historical rain data showed that Telangana has had slight increasing 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 1, 3, 4, 6, 12 and 13 – of these the latter two are the higher frequencies. These higher frequencies 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 later months but normal in June.

REFERENCES

[1] Telangana's Shocking Statistics: 350 Farmer Suicides in Five Months, http://www.ndtv.com/article/south/telangana-s-shocking-statistics-350-farmer-suicides-in-five-months-616371

[2] How Telangana Farmer's Suicide Has Changed the World of His Daughter. http://www.ndtv.com/article/south/how-telangana-farmer-s-suicide-has-changed-the-world-of-his-daughter-572462

[3] Telangana Government feels the Heat After Farmers' Suicide, http://www.khaleejtimes.com/kt-article-display1.asp?xfile=data/international/2014/November/international_November605.xml & section=international

[4] Farmer's Suicide in Vidarbha : Everybody's Concern, http://medind.nic.in/jaw/t09/i2/jawt09i2piii.pdf

[5] Farmers' Suicides in the Vidarbha Region of Maharashtra, India a Qualitative Exploration of Their Causes, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3291283/

[6] Daulatabad. http://en.wikipedia.org/wiki/Daulatabad,_Maharashtra .

[7] Sharan AM 2015. Prediction of Rain in Bihar, India, Based on Historical Rain Data. Environment and Pollution 2015; 12(3): 59-64.

[8] Evrendilek F and Berberoglu S. Quantifying Spatial Patterns of Bioclimatic Zones and Controls in Turkey. Theoretical and Applied Climatology 91(1-4): 35-50.

[9] Evrendilek F and Wali MK. Modelling Long-Term C Dynamics in Croplands in the Context of Climate Change: a Case Study From Ohio. Environmental Modelling and Software 16(4): 361-375.

[10] Aydin M, Yano T, Evrendilek F and Uygur V. Implications of Climate Change for Evaporation From Bare Soils in a Mediterranean Environment. Environmental Monitoring and Assessment 140(1-3): 123-130.

[11] Rainfall Projections. http://www.imdpune.gov.in/endofseasonreport2013.pdf.

[12] Delsole T and Shukla J. Geophys 2012. Res Lett 2012. http://dx.doi.org/10.1029/ 2012GL051279

[13] Gadgil S and Srinivasan J. Monsoon Prediction: are Dynamical Models Getting Better Than Statistical Models? J Current Science 2012; 103(3): 10 August.

[14] Excel - Time Series Forecasting. http://www.youtube.com/watch?v=gHdYEZA50KE.

[15] Frequency Domain Using Excel, http://online.sfsu.edu/jtai/downloads/ENGR%20302/Excel.FFT.pdf.

Received on 19-06-2015 Accepted on 17-07-2015 Published on 28-07-2015

DOI: http://dx.doi.org/10.15377/2410-3624.2015.02.01.4