International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161
©2017 INPRESSCO®, All Rights Reserved
Available at http://inpressco.com/category/ijcet

Research Article

Rain Prediction for the Year 2017 for Vidarbha India during the Monsoon Season

Anand M. Sharan*

Mechanical Engineering Department, Faculty of Engineering, Memorial University of, Newfoundland, St. John's, Newfoundland, Canada A1B 3X5

Received 30 May 2017, Accepted 31 July 2017, Available online 10 Aug 2017, **Vol.7, No.4 (Aug 2017)**

Abstract

In this work the rainfall in Vidarbha has been calculated based on rainfall data between 1985 to 2016.The calculations have been performed using Time Series method and Fast Fourier Transform (FFT) method. The results of these two methods are averaged for better reliability. The frequency domain analysis is carried out to explain the rapid variation of the quantity from year to year.

Keywords: *Monsoon rain prediction, Annual rainfall, Rainfall frequency spectrum, Flood control, Hydro-power generation*

1. The effect of variation of monsoon rain quantity on agriculture, water availability in cities and rural areas, and hydro-power generation

In India in the Monsoon season, one gets between 75 to 90% of the annual rainfall depending upon where one is within the boundaries of India. Since the country has widely different topography and forest distribution, the amounts of rain vary over wide ranges across the land. This rain water is used to fill tanks, ponds and other reservoirs or one can use this water for irrigation. In many areas close to 90% of fields are entirely dependent upon the annual Monsoon rain.

The rain water then flows to the rivers back to the ocean. The water in rivers and reservoirs also charge the underground water table. Many canals have been constructed to transfer water to distant lands for agriculture and water supply to municipalities. In north India, a part of water supply comes from melting of glaciers into various rivers.

The lack of rain causes immense hardships to people in day to day life. In many areas people even purchase water for drinking and other needs (Tamil Nadu gears up to… ,2017; In times of Drought …, 2016; India is facing…,2017). The crises created by shortage of rain have caused many farmers to commit suicide due to crop failure (Maharashtra government declares…, 2016; India drought drives…, 2016; Telangana government feels…, 2014; Farmer's suicide in Vidarbha.., 2009**;** Farmers' suicides in the Vidarbha region…, 2012). This also affects hydro-power generation (The thirst for power.., 2016; Drought: hydropower's Achilles heel .., 2016; Hydro power plants blamed…,2014). Similarly, such rainfall shortages can affect recharging of groundwater table (Groundwater recharge …, 2008).

2. Farmers suicides in Vidardha and adjoining areas

Years earlier, the farmers planted crops based on what the nature allowed for a particular location. For example in areas such as Marathwada, Vidarbha, Western Madhya Pradesh where the amount of rain was deficient - they planted millet (jowar), pearl millet (bajra) , and pulses. These crops do not require that much of water.

Later on farmers did not depend upon nature; they used pumps to pump groundwater using Diesel or electric pumps. Many of the farmers in these regions started cultivating high value crops which require intensive use of costly inputs (chemical fertilizers/ pesticides, hybrid seeds).

However, such measures were not cost effective as these pumps cause groundwater levels to go drastically down and in places drilling (an expensive process) for groundwater fails. Bearing in mind that the rain pattern remains erratic in these areas, this is the major reason of growing farmers suicides in these areas.

3. Planning of resources in agriculture and electrical power generation

The shortage of water creates difficulties in all countries but when it comes to countries with low per

*Corresponding author's ORCID ID: 0000-0003-1336-8333

capita income like India it brings disaster as the options get limited to solve individual's problems.

It is therefore very advantageous if one can have an idea of coming year's rainfall quantity. This will help in planning of sowing of the crop in agriculture or storing water in dams etc. Similarly one can plan for relief supplies for drought affected areas. In case of excess rains one can prepare for flood due to excessive rain or simultaneous release of water from dams built on a given river or its tributaries as it happened in case of floods in Ganga river in last year in the state of Bihar.

In view of above this research is carried out to achieve better accuracy in rainfall quantity and timelines prediction. In India, the Indian Meteorological Department (IMD) makes such predictions and there have been others who have carried out research in this field (Rainfall projections, 2013; Delsole, T. and Shukla, 2012; Gadgil, S and Srinivasan, J., 2012).

One thing to note is that in the present work it is possible to predict rain more than 8 months ahead of the onset of Monsoon season; it offers greater advantage over the predictions by others given in references 13 to 15. Over and above this, methods by others have been in the past - also less accurate and do not give sufficient time to farmers for planning for the crops as those predictions come about a month or two ahead of the Monsoon season. Similarly, this present method helps hydro-electric power generation companies to plan ahead for power generation. This method's results can be used in planning for dangers of flood.

The present work deals with predicting rain water for Vidarbha, a state in India which has gone through droughts in recent times where predictions by Indian Meteorological Department (IMD) have in the past were off by large amounts.

Since predicting amount of rainfall is a complex problem the idea here is to come up with improved models in order to come up with quantity of rain as close as the actual rain but within a reasonable tolerance. The global warming has added to the complexity of the problem since the rain pattern has become quite erratic. It is expected from the researchers to continue improving their models year after year so that the predictions are as close as possible to the actual rainfall values.

The location of Vidarbha is shown in Fig. 1. This figure also shows the locations of mountain ranges called Eastern and Western Ghats. Eastern Ghats are the mountain ranges run parallel to the Bay of Bengal. These are a discontinuous range of mountains along India's eastern coast. The Eastern Ghats run from the northern Odisha to Tamil Nadu in the south passing some parts of Karnataka. The Deccan Plateau lies to the west of the range, between the Eastern Ghats and Western Ghats. It rains quite abundantly in the coastal plains, including the Coromandel Coast region which lie between the Eastern Ghats and the Bay of Bengal. The heights of hills belonging to the Eastern Ghats are not as high as those in the Western Ghats. Since the direction of Monsoon in India is from the south-west direction, the effect of the height of Western Ghats affects drastically the regions east of these Western Ghats and this is where the areas of Telangana, Marathawada, and Vidarbha lie.

The deceptive part is the fact that the rain amounts vary at very rapid rate in successive years. This gives false hopes to farmers living in these areas. Later on in this paper, the occurrence of droughts will be explained from the rainfall spectrum.

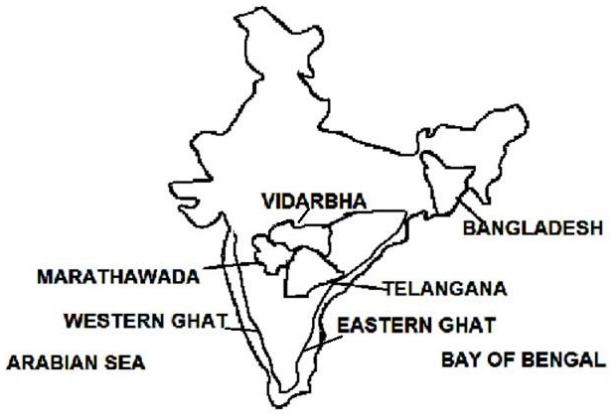

Fig.1 Locations of Marathawada Vidarbha and Telengana between western and eastern ghats

4. Rain data and analysis

The results of yearly rains are shown in Figs 2 to 5. The rainfall record starts from 1985 and goes up to 2016. The results include months of June to September, and the total amount of rain is shown in Fig. 6.

In Fig. 2 we see that the Fast Fourier Transform (FFT) model exactly reproduces the rainfall history since 1985. Here, we also see that the regression analysis (Time series method) results show an increasing trend overall. The predictions for 2017 for June by both methods are also quite close. To predict for 2017 Monsoon season, the prediction is based on the average of these two values which have been arrived at independently. The details about these two methods can be seen in (Excel - time series forecasting, 2013; Frequency domain using Excel, 2005).

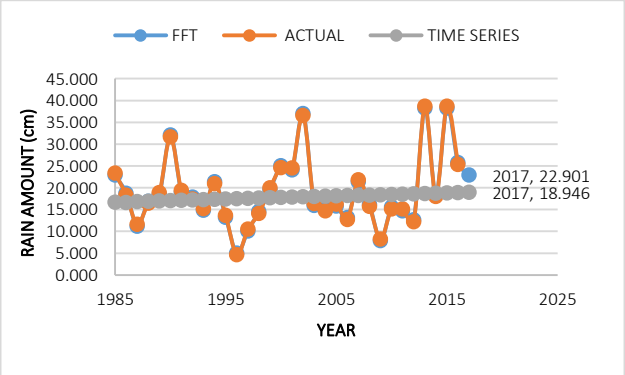

Fig. 2 Rain amount in June in Vidarbha

The results of all months are summarized in Table 1.

Table 1: Rain forecast in centimeters for Vidarbha during 2017 monsoon months

Method	Year	June	July	August	September	Total	Comment Total rain
Time series	2017	18.946	30.091	29.880	17.305	96.221	
Fast Fourier Transform (FFT)	2017	22.901	24.751	20.615	9.162	87.446	
Prediction- average of time series and FFT	2017	20.924	27.421	25.247	13.233	91.834	Below average but normal
Average of 32 yars		19.082	30.708	20.755	15.762	94.040	

Fig. 3 shows the rainfall for the month of July. Even here, the FFT method yields very accurate mapping of the actual rainfall. It shows increasing trend. In the recent past, the rainfalls have been excessive here. They show wide fluctuations from year to year.

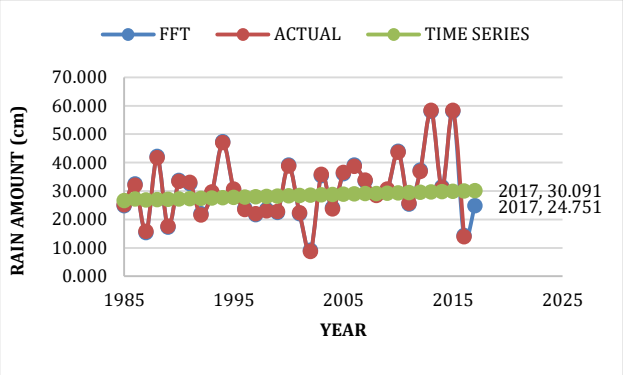

Fig. 3 Rain amount In July in Vidarbha

In Fig. 4 we see that the mapping by the FFT method is quite close. However, the two methods arrive at results which are apart. The trend is also increasing here. We also see that the results of the FFT method quite accurately matches with the actual values.

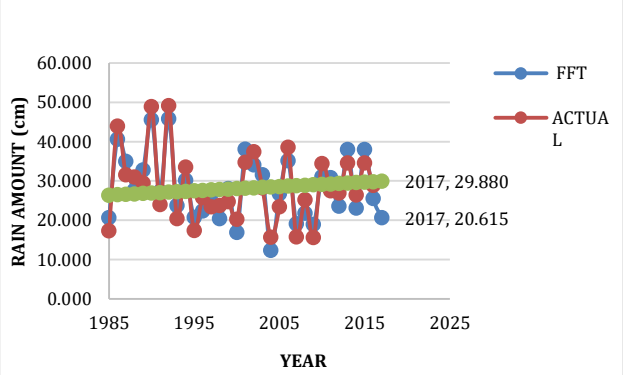

Fig. 4 Rain amount in August in Vidarbha

The rainfall history for September and prediction for this month are shown in Fig. 5. Here, the two methods differ more what than they did in the previous month. Here, the FFT method's values are close to the actual rainfall values. The trend is increasing even here.

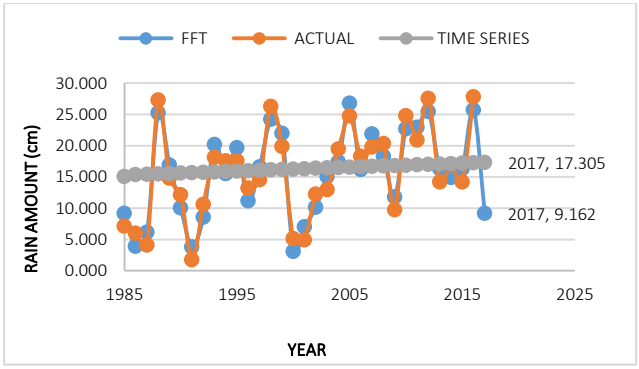

Fig. 5 Rain amount in September in Vidarbha

In Fig. 6, the actual rainfall values were added as total rain by summing the values for each of the months. The results were obtained as before. Again here, the FFT method results almost reproduce the actual rainfall values. The predicted results by two methods are not very far apart.

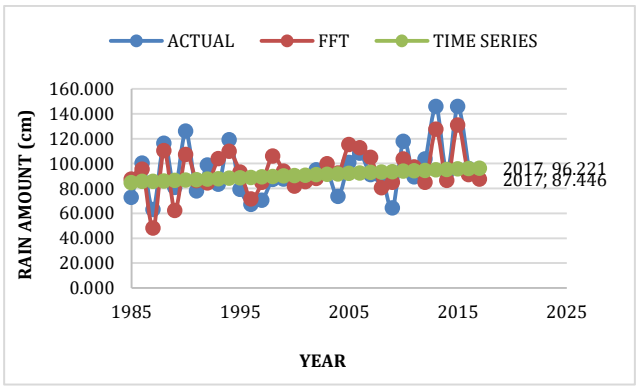

Fig. 6 Total rain amount in Vidarbha

In order to understand the reason for such a rainfall history (rapid variation) shown in Fig. 6, the spectral analysis of rainfall was carried out and the results are shown in Fig. 7. Here the amplitudes for the frequency numbers from 3 to 11 and 15 are higher than 6 centimeters where all of these amplitudes are calculated by the Fourier series. This figure shows that higher frequencies are quite significant and they results in rapid changes in rainfall values from one year to another.

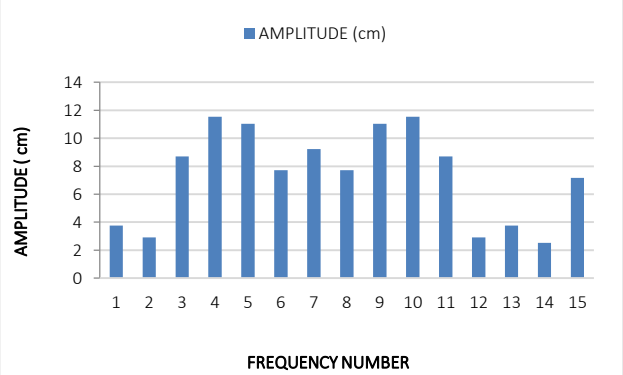

Fig. 7 Amplitude verus frequency number

Conclusions

In this work, at first a brief review of the rainfall shortage in India was carried out. It was found that Vidarbha has had severe drought conditions in the past. Based on this work one can conclude the following:

1) The historical rain data showed that Vidarbha has had slight increasing trend in rainfall (Time eries method).
2) The FFT method quite accurately maps the actual rainfall data in most cases even though the rain pattern is quite complicated.
3) The complicated and fast changing rainfall pattern arises due to the presence of higher frequencies whose amplitudes are above 6 centimeters.
4) The total rain will be in the normal range within 19% deviation from the mean of the 32 year rainfall history

References

Tamil Nadu gears up to tackle worst water shortage in over 140 years, 2017, http://www.thehindubusinessline.com /news/national/tamil-nadu-gears-up-to-tackle-worst-water-shortage-in-over-140-years/article9595958.ece

In times of drought: Overuse of water behind India's dry days, 2016,http://www.hindustantimes.com/india/in-times-of-drought-overuse-of-water-behind-india-s-dry-days/story-YiWENI7Cld92qrm0A0uM5L.html

India is facing Its worst water crisis in generations, 2017, https://qz.com/931878/india-is-facing-its-worst-water-crisis-in-generations/

Maharashtra government declares drought in 12,000 Vidarbha villages, 2016, http://indianexpress.com/ article/india/india-news-india/drought-declared-in-12000-vidarbha-villages/

India drought drives farmers to suicide, 2016, http://www.thenational.ae/world/south-asia/india-drought-drives-farmers-to-suicide

Telangana government feels the heat after farmers' suicide, 2014, http://www.khaleejtimes.com/kt- article-display1.asp?xfile=data/international/2014/November/international_November605.xml&sectio n=international

Farmer's suicide in Vidarbha : Everybody's concern , 2009, http://medind.nic.in/jaw/t09/i2/jawt09i2piii.pdf

Farmers' suicides in the Vidarbha region of Maharashtra, India a qualitative exploration of their causes, 2012,http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3291283/

The thirst for power: Hydroelectricity in a water crisis world, 2016,http://www.brinknews.com/the-thirst-for-power-hydroelectricity-in-a-water-crisis-world/

Drought: Hydropower's Achilles heel, 2016 ,https://www.internationalrivers.org/blogs/433/drought-hydropower-s-achilles-heel

Hydro power plants blamed for water shortages, 2014 , https://thewaternetwork.com/article-FfV/hydro-power-plants-blamed-for-water-shortages-YLYSK6XC4LQ9yq-vdpKGNA

Groundwater recharge, 2008,https:// en.wikipedia.org/ wiki/Groundwater_ recharge

Rainfall projections, 2013, http:// www.imdpune.gov.in/ endofseasonreport2013.pdf

DelSole, T., and J. Shukla, 2012: Climate models produce skilful predictions of Indian summer monsoon rainfall. *Geophys. Res*. Lett., 39, doi: 10.1029/2012GL051279.

Gadgil, S and Srinivasan, J., 2012, "Monsoon prediction: are dynamical models getting better than statistical models?", *J Current Science* ,Vol. 103, No. 3, 10 August 2012

Excel-Time Series Forecasting, 2013, http://www.youtube.com/ watch?v=gHdYEZA50KE

Frequency Domain Using Excel, 2005, http://online.sfsu.edu/ jtai/ downloads/ENGR%20302/Excel.FFT.pdf