Monsoon Rain Prediction for Year 2020 for Marathawada India

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Author’s contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Abstract

This work was undertaken to predict expected rainfall in year 2020 because Marathawada suffers frequently from drought and as a consequence, many farmers commit suicide. If rainfall is not enough then it is the farmer who suffers the most as compared to others who lend money, sell seeds etc. In doing so, sufficiently large period is used (past 32 years) in three methods other than the Artificial Neural Network (ANN) method where rainfall history back to AD 1872 is used in the analysis. In addition, some details about the four methods are also mentioned here.

To arrive at the predictions, four methods were used and their average value was used for predictions of rain for various months. The methods used were – the Fast Fourier Transform (FFT) method, the Artificial Neural Network (ANN) method, the Time Series method and the Root Mean Square (RMS) method. The result shows that this year there will be slightly more rainfall than the average of last 32 years.

Keywords: Monsoon rain prediction; annual rainfall; rainfall frequency spectrum; flood control; hydro-power generation.

1 Introduction

1.1 Water crisis in India

Encroachment of water bodies in the cities has been alarming as the land gets expensive. The builders have so far acquired the land near these bodies and built high rise buildings encroaching land within these water bodies. This way there is vast shortage of water in the cities. References [1-3] provide sufficient information regarding such shortages.

About 40% of the land in India is irrigated whereas the remaining depend on the rainwater. Also, between 75 to 90% of rainfall takes place during June to September. As the population is rising and with new
mechanization - demand for water is increasing day by day. Pumps in homes are being installed and with multi-storied buildings which has led to excessive pumping of water. Not only has this vast migration of workers from the rural areas to cities resulted in excessive demand for water in cities. The water supply system of the cities is overburdened.

Farmers borrow money for seeds and other supplies and pay in cash but the others involved in this chain are not participants in the loss process if there is a crop failure. Not only this, the food grains have an upper limit as far as return is concerned. The total price of food grain does not increase in proportion to the production as a result the farmers incur losses.

Water reserves exist in the form of (a) stored water in ponds, lakes, (b) those in flowing rivers plus (c) in form of snow or ice on the Himalayas. Another availability is in form of groundwater. In the case there is not enough rainfall then, one would have to dig into the reserves which have limits.

Water is needed for agriculture, daily usage in cities and villages, power generation, as well as in many industrial processes. The only new source or input is the rain-water.

Marathawada has been drought prone and therefore rainfall studies are very necessary. In this respect, the recent studies about the climate can be seen in [4-8].

As far as agriculture is concerned, water shortage results in large number of farmers suicides [9-13]. These shortage information can also be seen in [14-21]. Such a shortage also affects the hydropower generation [22].

One way to help in these uncertainties of rainfall would be to come up with rainfall amount prediction model where one can compute the expected rainfall well ahead of time. This way, the farmers can decide what to plant and how much to plant? The farmers are under heavy loans and a drought destroys hope of paying back the loans. In case of advance knowledge about a drought or amount of rainfall- will help farmers plan well and avoid loans that they cannot repay.

In the present studies about the prediction based on 32- year rainfall history of an area. From studies done for separate areas it has been found that in many cases a distance as little as 100 kilometer can lead to entirely different rain patterns.

This present method can also help in planning of hydro-electric power generation where generating companies can plan ahead if there will be enough water during the summer months. The results of this research can also be used in planning for dangers of flood. This is because dams have been built on rivers and their tributaries and if there is heavy rain over the catchment area then water from all the dams need to be released from time to time to avoid over-flooding in the dams. The simultaneous release of water from many dams causes flood in areas downstream.

There are other scientists who also publish their scientific works can be seen in in [23-25].

2 Analysis of Historical Data and Predictions

In the calculations here, four  methods were used which are (1) the Time Series method, (2) the Fast Fourier Transform method (FFT), (3) the Artificial Neural Network method ( ANN), and Mean Square method where on calculates this value based on linear regression analysis for each of the months separately over time history of 32 years.

In the Time Series method, the rainfall amount in each of the monsoon months – June, July, August, and September are considered as separate seasons in a given year. Then the overall trend is calculated for 32 year data using linear regression analysis. In calculations, the average departure of the rain for each of the months is also calculated. To arrive at the predicted rainfall amount is calculated using this information for each of the months of the year 2020.
In the Mean Square method, the linear regression is carried out monthwise and based on this corresponding rainfall amount is predicted.

In the Fast Fourier method, the history of the rainfall is approximated using Fourier series with spectral algorithm to minimize the number of computations. Based on the history and considering the trend – rainfall amount in the year 2020 is predicted.

In the ANN method, 32 year data from the year 1872 are used as the input vector and the rain amount in the 33rd year is used as the output vector to train the network. After this, next 32 year is obtained by incrementing the record of 1872 by the next record which will be year 1873. Consequently, the output vector becomes the 34th year from the year 1872. In this way, the final output vector will be the year 2019. After training the network this way, the prediction is made using the trained weights for the year 2020.

The result in summary form is presented in Table 1. The details about these methods can be seen in [26-28]. The frequency domain analysis is detailed in reference [29] and the Artificial Neural Network (ANN) in reference [30].

The location of Marathawada in Western India is shown in Fig. 1. Calculations of results are plotted monthwise for the months of June to September in Figs 2 to 5 respectively. The total value plot is shown in Fig. 6.

Table 1 shows the summary of results. The results using ANN method differs in the month of June as compared to the predicted result but they are not so much different in other months. Overall, there will be slightly higher rainfall this year as compared to the average rainfall for last 32 years.
Table 1. Rain forecast in centimeters for Marathawada during 2020 monsoon months

<table>
<thead>
<tr>
<th>Method</th>
<th>Year</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Total</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS linear</td>
<td>2020</td>
<td>19.5</td>
<td>34.7</td>
<td>27.3</td>
<td>20.8</td>
<td>102.3</td>
<td></td>
</tr>
<tr>
<td>FFT</td>
<td>2020</td>
<td>20.3</td>
<td>28.1</td>
<td>30.1</td>
<td>16.9</td>
<td>95.4</td>
<td></td>
</tr>
<tr>
<td>ANN</td>
<td>2020</td>
<td>11.7</td>
<td>32.1</td>
<td>28.2</td>
<td>22.0</td>
<td>94.0</td>
<td></td>
</tr>
<tr>
<td>Time series</td>
<td>2020</td>
<td>20.4</td>
<td>28.5</td>
<td>26.8</td>
<td>24.2</td>
<td>99.9</td>
<td>Slightly higher Than the 32 Year Average Value</td>
</tr>
</tbody>
</table>

Predicted amount
2020 | 18.0 | 30.9 | 28.1 | 21.0 | 97.9 |
32 year average | 19.1 | 30.5 | 28.5 | 17.1 | 95.2 |

Fig. 2. Rainfall in month of June in 2020 in Marathawada

Fig. 3. Rain amount in Marathawada in July 2020
In Fig. 2, the Time Series and Root Mean Square values have straight line variation due to the linear regression on one hand but the ANN and FFT methods follow the actual rain values and are close to each other.

Fig. 3 shows the rainfall for the month of July. Here the trend is higher with years. In the recent past, the rainfalls have been excessively low. They show wide fluctuations from year to year.

In Fig. 4 we see the same decreasing trend in RMS value but increasing in Time Series method. The predicted rain is more than that of June.

Fig. 5. Rain amount in Marathawada in September 2020
The rainfall history for September is shown in Fig. 5. It shows the increasing trend. The amount of rainfall in this month is less than those of months of July and August.

In Fig. 6, the actual rainfall values of different months were added up as total rain. The results were obtained as before. Here, there is overall not much difference in various method results - i.e. all yield closer final value for the year 2020.

Fig. 7 is a plot of amplitudes versus frequency numbers based on the results of Fourier analysis. Here, we see that frequency numbers 1, 3, 8 and 12, to 15 have significant amplitudes. All of the amplitudes have been calculated using the Fourier series. The rapid variation of total rainfall from year to year is due to the presence of many significant higher frequencies.

Fig. 6. Total rain amount in Marathawada in year 2020

Fig. 7. Amplitude versus frequency number
3 Conclusions

In this work a review of availability of water was carried out. It was seen that the rainfall is the main source of water for irrigation. Secondly, agriculture is highly dependent on rain.

It was seen that insufficient rain causes famines and also decreases agricultural production and hydro power generation

Based on this work one can conclude the following:

1. The historical rain data showed that Marathawada has had slight increasing trend in rainfall.
2. Overall, there has been an increasing trend in the rainfall pattern,
3. The complicated and fast changing rainfall pattern arises due to the presence of several significant higher frequencies.
4. Because of the increasing rainfall trend, there should not be water shortage this year.

Competing Interests

Author has declared that no competing interests exist.

References


[16] India is already facing a water crisis—and it is only going to get worse; 2015. Available: https://thediplomat.com/2014/04/indias-worsening-water-crisis/


[22] India's potable water crisis is set to worsen; 2016. Available: https://www.livemint.com › Politics › Policy


