

Analysis Of Rain Model For Drought Prone Areas Of India For The Year 2022

Anand M Sharan

ABSTRACT - Here, the calculations are done using four methods which are: The Root Mean Square (RMS) method, The Fast Fourier Transform (FFT) method, and the Artificial Neural Network (ANN) method. The predicted value is the average value obtained by these methods. This predicted amount is compared with mean rain amount of the past 32 years. The reason for this comparison is that the rain amount's statistical distribution is that of a normal distribution [1]. In the normal distribution, the mean value has the maximum probability.

INTRODUCTION AND LITERATURE SURVEY

India has one of the largest areas for cultivation in the world. However, about 66% of the cultivated area doesn't have irrigation facilities and these areas depend entirely on monsoon rain[2-5].

It is a fact that the rain is highly unpredictable and erratic in nature[1]. As a result of this the farmer's income is highly unreliable due to the unpredictability of the rain. This unpredictability of the farmer's income has high cost to the farmers of the country because the farmer has to purchase seeds, fertilizers etc. on cash basis and the farmer has to borrow the money at high interest from the banks or moneylenders. In addition, a large number of farmers have to rent the land for tilling. Whenever there is drought, the crop fails and the farmer's income takes a nosedive. Many farmers commit suicide because of the inability to pay back the loan.

The months contributing to the total rain amount are the month of June, July, August and September. Inadequate rain affects the entire country because the purchasing power of the farmers decreases thereby the demand for commodities of daily use decreases.

If a reliable method for annual rain amount is found then a lot of uncertainty of the farmers can be decreased and many suicides can be avoided. In the news one reads about suicides, and they are mostly in the areas of Vidarbha, Marathawada, Telangana, and Jharkhand where the rainfall is highly unpredictable. One can read about water scarcity or farmers suicides in [6-27].

This work has been taken up to make the forecast about seven months in advance so that a farmer has information about the monsoon rains well in advance - about seven months ahead of the monsoon rains. The farmer's expenses are towards the purchasing of fertilizers, and other supplies. The early forecast helps the farmers even in the case of renting of the land for cultivation.

Figure 1 shows The areas of Maharashtra, Telangana, Jharkhand, and Vidarbha. The monsoon clouds appear from the southwest direction and the areas between the western and eastern ghats lie in the shadows of these ghats and suffer from lack of rain.

The lack of rain affects the electrical power generation also [28]. There is rationing of electricity just before monsoon in many parts of India.

The forecasting in this work is based on calculations using four methods which are: (1) the Time Series method, (2) the Fast Fourier Transform method (FFT), (3) the Artificial Neural Network method (ANN), and Root Mean Square method (RMS) method. The details about these methods can be known by going through references [29-33].

In the RMS method, the linear regression is used where the square root of the deviations from the linear values are minimized. In this analysis the data over past 32 years are used. This process is carried out for each of the months separately. In the Time Series method, one uses the months of June, July, August, and September as separate seasons. The time history of 32 years is used as mentioned for the previous method.

In the ANN method, the calculations are done going back to 1875. Here, the calculations are done in batches of 32 years as input and the output is the data for the 33rd year. In the following step, one shifts by one year and repeats the process. In this way, one progresses to the last year.

Having trained the network this way, the prediction of the rain for the year 2022 was based on the data of 32 years which ends at the rain of the current year as the input set and the output value is the forecasted value.

The Fast Fourier Transform (FFT) method The Fourier coefficients are calculated using a faster algorithm.

Finally, the average value of the results given by four methods is used for the actual forecast.

RESULTS AND DISCUSSIONS

Figures 2 to 5 show the total values of the rain for these areas which are- Jharkhand, Vidarbha, Telangana, and Marathawada. These figures show the fact that the rain amounts differ very sharply from year to another.

Table 1 shows the results of various methods and the predicted amount based on the average value of all these methods. This table shows that the results of various

methods differ from each other. This table also shows that the predicted amount is closer to the actual rain amount as compared to the 32 year average which had the maximum probability due to its normal distribution.

Table 2 shows the results of for Vidarbha. Even here it shows that the predicted value is better than the 32 year average value.

Table 3 shows the results for Telangana. it shows that the results using various methods show large amount of error and consequently , the predicted value has considerable error but less than the 32 year average value.

Table 4 shows the results for Marathawada. Even here the results of four methods show larger errors and so does the predicted value. In this case here, the error in 32 year average value is less than the predicted value.

Table 5 shows the results for different areas. Here the 32 year average rain value error is greater than that of the predicted value. This table clearly shows the utility of the modeling for rain forecasting by the author.

Table 6 shows the performance of various methods. It shows that the Time Series method is by far the best method and the results of the ANN method have maximum error.

CONCLUSIONS

In the present work the data from the 32 year old history of rain was used for making forecasting. To make the forecast four methods were used. The performances of various methods were checked for different areas in Table 6. The predicted value used was the average of the values of the four methods.

Figures 2 to 5 showed that the rainfall amount varies in an erratic manner from year to year.

Tables 1 to 4 dealt with the rainfall amount for specific areas. In these tables, the predicted value yielded better results than the 32 year average value in most of the cases.

Table 5 shows that the predicted value for each of these areas on an average leads to the better results.

Table 6 shows that the Time Series method is the best method to be used.

As far as this subsidy is concerned, the Indian farmers get much smaller subsidies ice compared to the farmers of industrialized countries[34]. It is difficult for the Indian farmers to make living depending entirely on agriculture.

REFERENCES

1. Sharan, A. M., 2015, “ Prediction of Rain in Bihar, India, Based on Historical Rain Data “ , Environment and Pollution, Vol. 12, No. 3 , pp. 59–64
2. The percentage of irrigated land in India is about, <https://www.vedantu.com/question-answer/the-percentage-of-irrigated-land-in-india-is-class-10-social-science-cbse-5fc86b12fc3d9653700e8cd1> Climate change is remaking South Asia's monsoon , <https://www.economist.com/asia/2021/06/19/climate-change-is-remaking-south-asias-monsoon>
3. A drink of clean water, https://www.compassion.ca/blog/a-drink-of-clean-water/?utm_source=google&utm_medium=paid-search&utm_campaign=&utm_term=water%20crisis%20in%20india&appeal=AdWords&gclid=CjwKCAiAvOeQBhBkEiwAxutUVGq8AavDjnNVQ40Y7nspEVMF7USwEgNl4V4IlyBZEm_3pZHVp32R-hoCdiIQAvD_BwE
4. Water Scarcity in India: A Human Crisis I India Loud & Clear I EP 7 , https://www.videovolunteers.org/water-scarcity-in-india-a-human-crisis-i-india-loud-clear-i-ep-7/?gclid=CjwKCAiAvOeQBhBkEiwAxutUVBOSCMfysLVwJi8VmTyZlYFGRyW7YkISyG5C-n6jQenI51VWPTKIghoCJSgQAvD_BwE
5. India's water crisis: It is most acute for women - Down To Earth, <https://www.downtoearth.org.in/blog/water/india-s-water-crisis-it-is-most-acute-for-women-78472>
6. “Second wettest Sept in 27 years bridges Monsoon deficit” (2021).
7. “Droughts, water shortage: Here's why Marathwada isn't giving up Sugarcane”(2020).
8. “Six out of 9 major dams in Marathwada reel under water shortage”(2019).
9. “How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood” (2019).
10. “Farmers stare at drought as Jharkhand rain deficit crosses 50%” (2019).
11. “Jharkhand witnesses 35% rainfall deficit” (2019).
12. “Water Shortages in India” (2019).
13. “What lack of rainfall could mean...?”.
14. Erratic Monsoon Haunts India; 33% Rainfall Deficit in June (2019).
15. How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood (2019).

16. Staring at acute water shortage, India witnesses driest June in 5 years (2019).

17. Singh K., et al. "A Study on Variability in Rainfall over India Contributed by Cyclonic Disturbances in Warming Climate Scenario". International Journal of Climatology 40.6 (2020): 3208-3221.

18. Mathur R and AchutaRao K. "A Modelling Exploration of the Sensitivity of the India's Climate to Irrigation". Climate Dynamics 54 (2020): 1851-1872.

19. Prathipati VK., et al. "Inconsistency in the frequency of rainfall events in the Indian summer Monsoon season". International Journal of Climatology 39.13 (2020): 4907-4923.

20. Southwest Monsoon 2020: Good rains now bring bad news.

21. Heavy rains lash Maharashtra, north India reels under sultry weather.

22. NMC likely to get only 50% of raw drinking water demand (2018).

23. Water crisis looms in Vidarbha and Marathwada as summer arrives (2018).

24. "Water Scarcity and Security in India".

25. Telangana's Shocking Statistics: 350 Farmer Suicides in Five Months.

26. Farmer's Suicide in Vidarbha: Everybody's Concern.

27. India's fast-growing cities face water crisis - Phys.org (2015).

28. "Groundwater Recharge" (2008).21

29. "The Thirst for Power: Hydroelectricity in a Water Crisis World" (2016).

30. "Rainfall Projections".

31. "Excel - Time Series Forecasting".

32. "Frequency Domain Using Excel".

33. Sharan AM and Balasubramanian R. "Design Of Four-Bar Mechanism By Neural Network Methods". International Journal of Modelling and Simulation 19.1 (1999): 1-6.

34. Agricultural subsidy, https://en.wikipedia.org/wiki/Agricultural_subsidy the Eastern and Western Ghats of India



Fig. 1 Location of Jharkhand, Telangana, Vidarbha, and Marathawada between

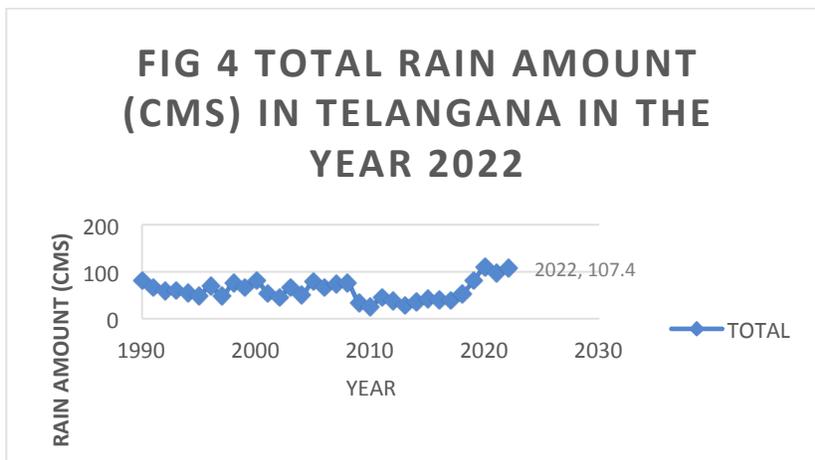
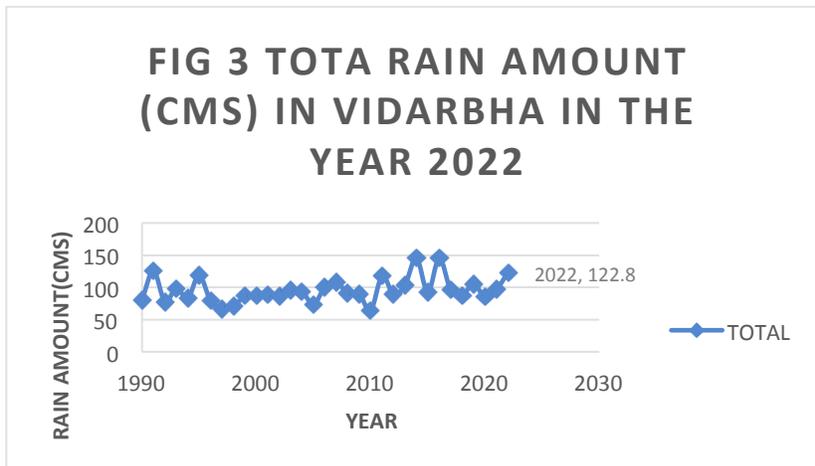
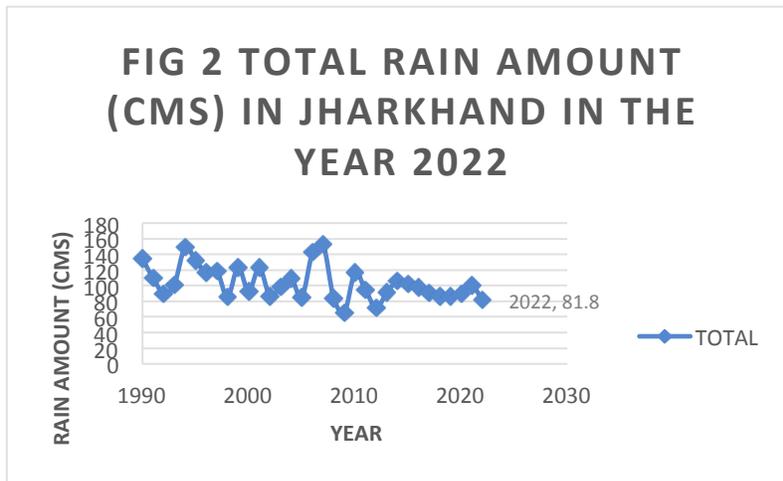


TABLE 1: RAIN FORECAST IN CENTIMETERS FOR JHARKHAND DURING 2022 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	PERCENT ERROR FROM ACTUAL
RMS	2022	12.2	33.7	28.1	18.2	92.2	12.7
TIME SERIES	2022	21.3	21.2	21.2	21.1	84.8	3.7
FFT	2022	16.1	31.7	27.5	22.9	98.2	20.0
ANN	2022	25.3	30.9	39	13.8	109	33.3
PREDICTED	2022	18.725	29.375	28.95	19	96.05	17.4
ACTUAL	2022	9.57	16.13	32.86	23.24	81.8	0.0
32 YEAR AVERAGE	2022	19.6	32.8	29.8	21.8	104.1	27.3

TABLE 2: RAIN FORECAST IN CENTIMETERS FOR VIDARBHA DURING 2022 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	PERCENTAGE ERROR FROM ACTUAL
RMS	2022	21.2	33.9	26.4	22.2	103.6	15.6
TIME SERIES	2022	21.2	29.6	27.9	25.2	103.8	15.5
FFT	2022	13.5	38.2	33.3	22.1	107.2	12.7
ANN	2022	24	35	37.1	9.9	105.9	13.8
32 YEAR AVERAGE		19.3	30.4	28.1	16.9	94.7	22.9
ACTUAL	2022	10.68	56.48	30.74	24.9	122.8	0.0

TABLE 3: RAIN FORECAST IN CENTIMETERS FOR TELANGANA DURING 2021

MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	% ABSOLUTR ERROR FROM ACTUAL
RMS VALUES	2022	15.1	29.6	15.1	16.1	75.9	29.3
TIME SERIES	2022	29.8	28	28.6	16.7	103.1	4.0
FAST FOURIER TRANSFORM (FFT)	2022	11.5	17	19	15.3	62.8	41.5
ANN METHOD	2022	19.6	19.9	9.3	16.4	65.2	39.3
PREDICTED AMOUNT	2022	13.9	17.2	18.9	11.7	76.8	28.5
ACTUALL	2022	14.28	53.52	18.2	21.4	107.4	0.0
32 YEAR AVERAGE		10.6	16.8	19.1	12.8	59	45.1

TABLE 4: RAIN FORECAST IN CENTIMETERS FOR MARATHAWADA DURING 2022 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	PERCENT ERROR
RMS	2022	21.1	31.1	23.8	24.5	100.5	26.6
TIME SERIES	2022	29	27.2	27.7	16.2	100.2	26.2
FFT	2022	7.9	37	37	21.2	104.4	31.5
ANN	2022	14.2	27.5	26	17.4	85.1	7.2
PREDICTED - AVERAGE OF ABOVE	2022	18.1	30.7	28.6	19.8	97.6	22.9
ACTUAL	2022	14.44	35.16	8.7	21.1	79.4	0.0
32 YEAR AVERAGE	2022	19.4	29.7	27.4	17	93.5	17.8

TABLE 5 AVERAGE ERROR IN CALCULATIONS FOR ALL AREAS

AREA	JHARKHAND	TELANGANA	VIDARBHA	MARATHAWADA	AVERAGE PERCENTAGE ERROR
PREDICTED PERCENT ERROR BY AUTHOR	17.5	28.5	14.4	22.9	20.8
32 YEAR AVERAGE	27.3	45.1	22.9	17.8	28.3

TABLE 6: PERCENTAGE ERROR IN VARIOUS METHODS

AREA	RMS	TIME SERIES	FFT	ANN
JHARKHAND	12.7	3.7	20	33.3
VIDARBHA	15.6	15.5	12.7	13.8
TELANGANA	29.3	4	41.5	39.3
MARATHAWADA	21.1	29	7.9	14.2
AVERAGE PERCENTAGE ERROR	19.7	13.1	20.5	25.2

BIBLIOGRAPHY

1. "Second wettest Sept in 27 years bridges Monsoon deficit" (2021).
2. "Droughts, water shortage: Here's why Marathwada isn't giving up Sugarcane"(2020).
3. "Six out of 9 major dams in Marathwada reel under water shortage"(2019).
4. "How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood" (2019).
5. "Farmers stare at drought as Jharkhand rain deficit crosses 50%" (2019).
6. "Jharkhand witnesses 35% rainfall deficit" (2019).
7. "Water Shortages in India" (2019).
8. "What lack of rainfall could mean...?".
9. Erratic Monsoon Haunts India; 33% Rainfall Deficit in June (2019).
10. How Acute Water Shortage in Tamil Nadu Has Dampened Rain Effect in Kollywood (2019).
11. Staring at acute water shortage, India witnesses driest June in 5 years (2019).
12. Singh K., *et al.* "A Study on Variability in Rainfall over India Contributed by Cyclonic Disturbances in Warming Climate Scenario". *International Journal of Climatology* 40.6 (2020): 3208-3221.
13. Mathur R and AchutaRao K. "A Modelling Exploration of the Sensitivity of the India's Climate to Irrigation". *Climate Dynamics* 54 (2020): 1851-1872.
14. Prathipati VK., *et al.* "Inconsistency in the frequency of rainfall events in the Indian summer Monsoon season". *International Journal of Climatology* 39.13 (2020): 4907-4923.
15. Southwest Monsoon 2020: Good rains now bring bad news.
16. Heavy rains lash Maharashtra, north India reels under sultry weather.
17. NMC likely to get only 50% of raw drinking water demand (2018).
18. Water crisis looms in Vidarbha and Marathwada as summer arrives (2018).
19. "Water Scarcity and Security in India".
20. Telangana's Shocking Statistics: 350 Farmer Suicides in Five Months.
21. Farmer's Suicide in Vidarbha: Everybody's Concern.
22. India's fast-growing cities face water crisis - Phys.org (2015).
23. "Groundwater Recharge" (2008).
24. "The Thirst for Power: Hydroelectricity in a Water Crisis World" (2016).
25. "Rainfall Projections".
26. "Excel - Time Series Forecasting".
27. "Frequency Domain Using Excel".
28. Sharan AM and Balasubramanian R. "Design Of Four-Bar Mechanism By Neural Network Methods". *International Journal of Modelling and Simulation* 19.1 (1999): 1-6.