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ANALYZE THE RAINFALL DATA USING HARMONIC ANALYSIS IN THE AGRO CLAIMATIC AREA KANCHEEPURAM

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Abstract
It is known that the trigonometric functions sinx and cosx are otherwise called periodic functions, since their values repeate itself periodically. Hence a combination of the two could better express the behaviour of any time series which is periodic. The time series data on the rainfall expresses cyclic variations, every year. Hence it was thought appropriate to use the combination of sine and cosine functions otherwise known as the Fourier series expression as an appropriate tool to analyze the rainfall data.

Methodology

Harmonic Analysis was attempted to predict the average rainfall in each month for the selected area Kancheepuram.
The details of rainfall for each one of the months over the 50 years were exhibited in the scatter diagram. For each monthly data periodic oscillations were observed and hence an equation of the form

$$y = \frac{a_0}{2} + \sum_{i=l}^{n} \left(a_i \cos itz + b_i \sin itz \right)$$

was attempted. In this
y is the average monthly rainfall.
t month from January to December

a_i and b_i are the Fourier constants.
i is the harmonic number.
n is the end value of the order of the harmonic used.
z = 360°/12 = 30°

Results and Discussion

Zone One: Kancheepuram and Thiruvannamalai

The estimated value of the coefficients for Kancheepuram is presented below in Table 3.1.2.

Table 3.1.2: Estimated Fourier Co-efficient for Kancheepuram

a		**b**	
a_0	1.265		
a_1	1.062	b_1	1.112
a_2	0.896	b_2	-0.899
a_3	-0.811	b_3	0.736
a_4	0.793	b_4	0.602
a_5	0.721	b_5	-0.541
a_6	-0.387	b_6	0.321
a_7	0.116	b_7	0.227
a_8	0.071	b_8	-0.046
a_9	-0.006	b_9	0.016

The measured and expected rainfalls are presented in Table 1.1 for Kancheepuram, using the estimated harmonic coefficients. It is generally observed that the estimated rainfall levels are higher on lower harmonics and there after showed a decrease and the level of harmonic was terminated as soon as we noticed an increase again. For Kancheepuram it was observed that the difference between the observed and expected is minimum for the eighth harmonic.

Table 1.1: Absolute Deviations for the Observed and the Estimated Rainfall by Different Harmonics Kancheepuram

Months	5 HAR	6 HAR	7 HAR	8 HAR	9 HAR
January	10.8451	10.2173	9.7528	9.2347	9.8854
February	11.5216	11.4827	10.9521	10.4475	10.9218
March	10.7814	10.5532	10.0361	9.7851	9.9944
April	10.9537	10.7816	10.3792	9.6854	10.2562
May	11.4627	11.2189	10.6978	10.2103	11.0405
June	9.1453	8.7521	8.3269	7.9541	8.5321
July	8.4268	8.0132	7.9014	7.2236	7.9689
August	9.9653	9.3753	8.8257	8.2619	9.1893
September	10.6410	10.3375	9.8973	9.2167	9.9538
October	8.4131	8.7512	8.2158	7.4518	8.5183
November	8.2248	8.0048	7.7653	7.1153	8.1689
December	9.4537	9.2186	8.7431	8.2751	8.8894

Thus in the case of Kancheepuram the absolute deviations for observed and estimated were estimated upto the eighth Harmonic and is minimum for the 8^{th} harmonic as seen in table 1.1

Results presented in Table 1.1 reveal that the absolute deviations are minimum only during the months of June, July, October and November in all the harmonics and is maximum during the month of February in all the harmonics. This shows that the predictability is higher if it is a rainfall season and in the non-seasonal periods, it is natural that the variability will always be higher and that is being reflected in this analysis. The deviations started increasing from the ninth harmonic onwards and hence the computation of harmonics is stopped at the ninth.

These deviations were tested through chi-square and the estimated chi-square are presented below in Table 1.1.1

Table 1.1.1: Chi-Square Values between the Observed and the Estimated Rainfall for Different Harmonics Kancheepuram

Months	5 HAR	6 HAR	7 HAR	8 HAR	9 HAR
January	10.993	10.688	10.337	9.909	10.351
February	10.851	10.579	10.382	10.042	10.287
March	10.456	10.247	9.975	9.761	9.989
April	10.283	9.985	9.541	9.386	9.831
May	9.952	9.753	9.332	8.937	9.363
June	9.256	9.082	8.857	8.313	8.788
July	8.731	8.528	8.334	8.108	8.475
August	9.456	9.117	8.846	8.526	8.994
September	10.514	10.378	10.135	9.881	10.327
October	8.562	8.317	8.083	7.854	8.367
November	8.992	8.769	8.536	8.212	8.643
December	9.256	8.853	8.721	8.563	8.943

The Chi-square value also shows that the minimum chi-square is for October followed by July, November and June. For all other months the results showed higher deviations. As explained earlier this might probably be due to the fact that regular rainfall occurred in this station in all the above four months and in the other months there is no consistency of rainfall. This is again ascertained by the minimum coefficients of variation values in the regular rainfall months and the higher coefficient of variability in the non-seasonal months.

The mean, standard deviation, coefficient of variation, skewness and kurtosis are presented below in Table 1.1.2

Table 1.1.2: Mean, Standard Deviation, Coefficient of Variation, Skewness and Kurtosis Kancheepuram

Months	Mean	S.D	C.V	Skewness	Kurtosis
January	118.25	64.38	54.44	0.957	1.002
February	132.74	82.51	62.15	0.893	0.936
March	157.31	96.42	61.29	0.993	1.114
April	212.36	101.31	47.70	1.085	0.883
May	320.52	154.78	48.29	1.134	-0.667
June	643.28	246.51	38.32	0.782	0.986
July	936.38	312.31	33.35	0.664	0.821
August	432.31	216.64	50.11	0.899	1.151
September	214.58	187.54	87.39	0.994	-1.210
October	1342.11	465.66	34.69	0.715	0.768
November	1216.72	454.31	37.33	0.826	0.941
December	611.4	289.81	47.40	-1.143	-0.967

The results presented above table reveals that it is in agreement with the results got through harmonic analysis.

Conclusion

The Harmonic Analysis reveals the proximity between the observed rainfall and expected rainfall during the rainy season as expressed by the coefficient of variation. It should be noted that the order of the harmonic, which reaches the closeness, indicates the cyclic period of the rainfall. Thus the harmonic analysis of rainfall data shows the period of possibility for drought as well as the year of heavy showers.

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